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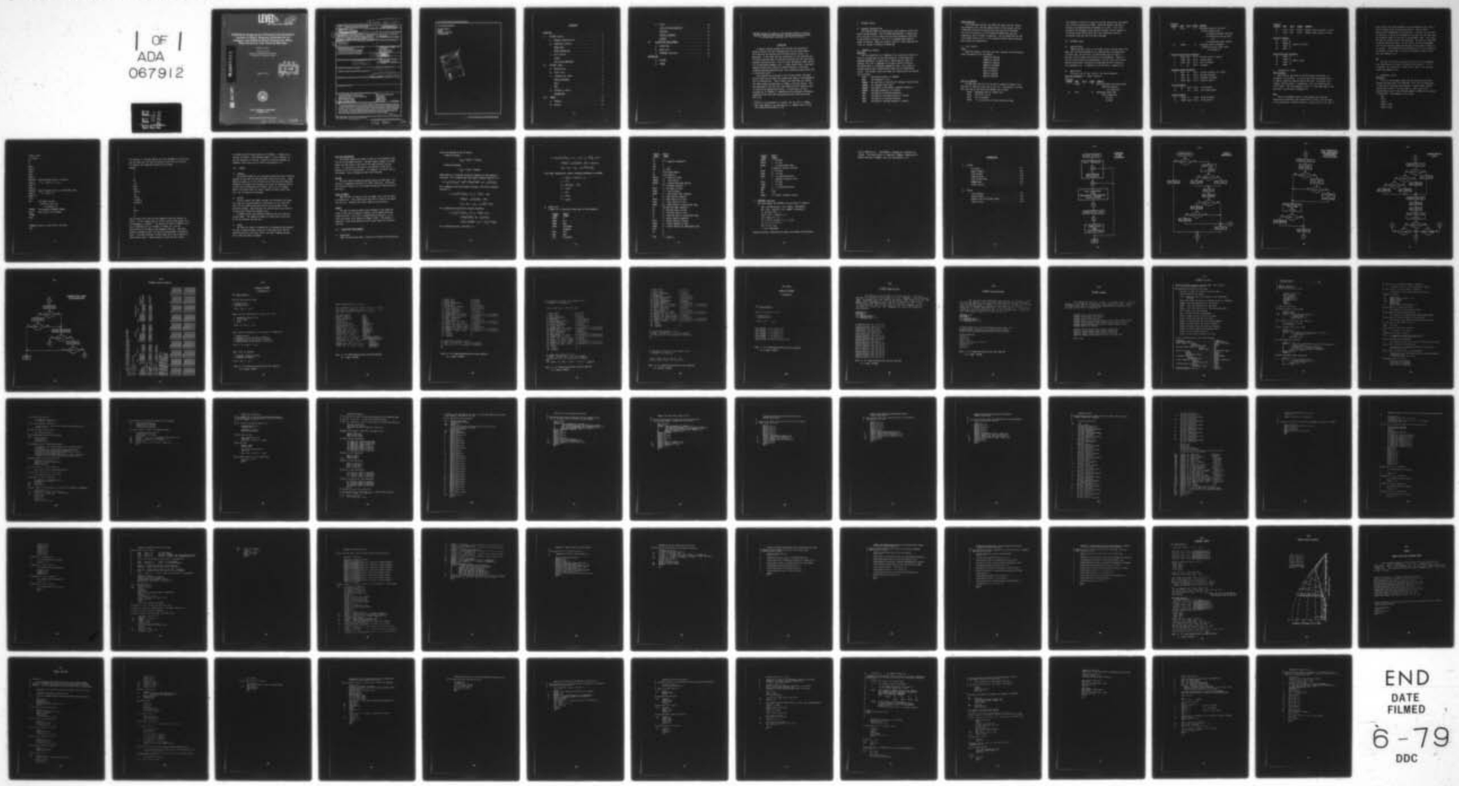

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NRL Memorandum Report 3885

# FORTRAN Programs for Numerical and Graphical Analysis of Elastic Response, Radiated Sound Pressure, and Reflected Sound Pressure for Plane Plate Structures with Fluid on One Side


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April 12, 1979


NAVAL RESEARCH LABORATORY
Washington, D.C.

14 NRL-MR-3885

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

## 9 REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ~~NRL~~ Memorandum ~~Report~~ ~~3885~~

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): 6 FORTRAN PROGRAMS FOR NUMERICAL AND GRAPHICAL ANALYSIS OF ELASTIC RESPONSE, RADIATED SOUND PRESSURE, AND REFLECTED SOUND PRESSURE FOR PLANE PLATE STRUCTURES WITH FLUID ON ONE SIDE.

5. TYPE OF REPORT & PERIOD COVERED: Interim report on a continuing NRL problem

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): 10 Martin D. Ring

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Naval Research Laboratory
Underwater Sound Reference Detachment
P. O. Box 8337, Orlando, Florida 32856

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
PE 61153N-11
Project RR011-08-42
NRL Problem S02-46

11. CONTROLLING OFFICE NAME AND ADDRESS

12. REPORT DATE: 11 Apr[redacted]79

13. NUMBER OF PAGES: 80

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 12 81p.

15. SECURITY CLASS. (of this report): UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

16 RR01108

17 RR0110842

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Timoshenko-Mindlin Thick Plate Theory
Composite Plane Plate Acoustic Computations
Elastic Response Function
Plates with welded coatings
Plates with slipping coatings
Plates with constrained layers
Plate coatings
Radiated Sound
Reflected Sound
Plate Acoustics
(Continues)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)


A computer program is developed to compute radiated and reflected sound pressures as a function of angle at a given frequency or as a function of frequency at a given angle for infinite plate structures excited by a point force or by plane acoustic waves. The plate structures have a fluid on one side, and air on the other. To compute radiated and reflected pressures, it is necessary to compute the elastic response function and several characteristic parameters of the structure. The ability to change the way in which these calculations are computed is a major factor in program design.


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S/N 0102-014-6601



SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

251 950

**19. Key Words (Continued)**

**Interactive Graphics**
**Plotting**
**FORTRAN 4 Plus (F4P)**
**FORTRAN (FOR)**



## CONTENTS

FORTRAN Programs for Numerical and Graphical Analysis of Elastic Response, Radiated Sound Pressure, and Reflected Sound Pressure for Plane Plate Structures with Fluid on One Side

# OVERVIEW

A computer program package that evaluates the theoretical formulas derived from the Timoshenko-Mindlin thick plate theory, which describe the radiated and reflected acoustic fields[1], is described. It was found that the expressions for the radiation and reflection were the same for each case analyzed, but that the elastic response function was not. The four cases implemented, whose results will be described elsewhere[2] are: a simple plane plate, a two-layer composite plate with a perfectly welded interface, a two-layer-slipping interface-composite plate, and a welded two-layer plate with a constraining layer.

Two programs are discussed in the following pages, the major portion taken up by PLTWAV, the program that does all the computation and file manipulation. Input, output, and algorithms are covered. The other program included here is TRACE, a plotting routine. This was developed so that the data from PLTWAV could be viewed on a CRT or plotter with appropriate scaling. In both cases, all the programs are in FORTRAN 4+, compatible with the Digital Electronics Corporation PDP 11/45 with the system RSX-11D or RSX-11M on the PDP 11/34.

-----

[1] Article to be published in J. Acoust. Soc. Am. by A.J. Rudgers

[2] NRL Formal Report to be published by A.J. Rudgers and M.D. Ring

Note: Manuscript submitted January 18, 1979.

# I. PLTWAV OUTPUT

## A. GENERAL DESCRIPTION

The program PLTWAV is constructed so that numerical and/or plot output can be obtained. The file WAVDT.DAT;VERSION is created each run to provide a list of input and calculated parameters pertaining to the physical structure. This file is expanded when numerical output is desired. When plot output is desired, eight separate plot files are created in addition to WAVDT.DAT.

## B. NUMERICAL OUTPUT

WAVDT.DAT

The file WAVDT.DAT is a formatted file, a new octal version of which is created each run for the purpose of listing input and computed parameters in complex form. When numerical output is desired, this file is appended to include an entire listing of calculated data in a tabulated exponential form. Each column is written using an E12.5 format which yields five (5) significant digits. The columns, which are broken and labeled every ten entries, are as follows:

| | |
|---|---|
| THETA | The emission angle $\theta$ in degrees |
| FREQ | The frequency f in Hz |
| ROMEGA | The real part of the electric response function Re[$\Omega$] |
| IOMEGA | The imaginary part Im[$\Omega$] |
| MOMEGA | The modulus of the elastic response function $\Omega$ |
| AOMEGA | The angle (phase) of $\Omega$ in radians |
| MREF | The modulus of reflected pressure |
| AREF | The phase of reflected pressure in radians |
| MRAD | The modulus of radiated pressure |
| ARAD | The phase of radiated pressure in radians |

ARRAY WAVDT(10)

The information written into WAVDT.DAT comes from two sources. The parameters come from the common section of the program, called PLTWAV.COM, while the calculated data come from the array WAVDT. The array is written to in the subroutine WAVDAT each time the computation loop of PLTWAV is completed. The file WAVDT.DAT has the array WAVDT written into it in the subroutine WRTFIL before the next pass through the computations.

## C. PLOT OUTPUT

FILES

When plot output is desired, new octal versions of the following eight unformatted files are created:

IOMEGA.PLT;VERSION
ROMEGA.PLT;VERSION
MOMEGA.PLT;VERSION
AOMEGA.PLT;VERSION
MREF.PLT;VERSION
AREF.PLT;VERSION
MRAD.PLT;VERSION
ARAD.PLT;VERSION.

PLOT FILE CONTENTS

In each case, the plot file contains a heading followed by the data that is implied by the name of the file. The heading is written into the files by the subroutine HEADER, and includes:

| | |
|---|---|
| IHEAD | Designates real or integer data |
| XINIT | The first X value |
| XDELT | The X increment |
| ITERM | = -1 to say that no further heading follows. |

This heading is used by all the plot routines contained by the system used, with the exception of TRACE. Below the heading, the data is written using separate WRITE statements for X and Y. The X axis represents the parameter being searched through, either frequency F or emission angle THETA, while the Y axis takes data from the calculated value that the file name indicates.

## II. PLTWAV INPUT

### A. DESCRIPTION

Before the user tries to run PLTWAV, several choices need to be made, the first being whether to run interactively or automatically. In either case, the user must also decide what type of output is desired, and the range of the search to be implemented. These are the first data inputs the program needs. All the input that follows defines the physical structure to be analyzed and the information for subsequent runs. A complete run can be found in Appendix A-3.

### B. INPUT DATA

The chart that follows lists all the input parameters.

Decision Parameters (=> means "implies")

| REFERENCE NUMBER | NAME | UNITS | FORMAT | COMMENTS |
|---|---|---|---|---|
| - | IAUTO | - | I1 | IAUTO designates the running mode<br>IAUTO=1=>automatic<br>=2=>interactive |
| 23 | IDAT | - | I1 | designates output type<br>IDAT=1=>Numerical<br>=2=>Plot<br>=3=>Both |

| REFERENCE NUMBER | NAME | UNITS | FORMAT | COMMENTS |
|---|---|---|---|---|
| 24 | ITYPE | - | I1 | designates physical structure<br>ITYPE=1=>Simple plate<br>=2=>Composite-Welded interface<br>=3=>Composite-Slipping inter-face<br>=4=>Constrained layer problem |
| 25 | ISERCH | - | I1 | designates search parameter<br>ISERCH=1=>Emission angle THETA<br>=2=>Frequency F |

Emission Angle Search Parameters

| | | | | |
|---|---|---|---|---|
| 1 | THMIN | Deg. | F10.0 | Minimum angle for search |
| 2 | THMAX | Deg. | F10.0 | Maximum angle |
| 3 | THINC | Deg. | F10.0 | Angle increment |
| 4 | F | Hz. | F10.0 | Frequency |

Frequency Search Parameters

| | | | | |
|---|---|---|---|---|
| 5 | FMIN | Hz. | F10.0 | Minimum frequency for search |
| 6 | FMAX | Hz. | F10.0 | Maximum frequency |
| 7 | FINC | Hz. | F10.0 | Frequency increment |
| 8 | THETA | Deg. | F10.0 | Emission angle θ |

Fluid Parameters

| | | | | |
|---|---|---|---|---|
| 9 | RO | $kg/m^3$ | F10.0 | fluid density |
| 10 | C | m/s | F10.0 | fluid sound speed |

Plate Parameters

| | | | | |
|---|---|---|---|---|
| 11 | HPLAT | m | F10.0 | Plate thickness |
| 12 | ROPLAT | $kg/m^3$ | F10.2 | Plate density |

| REFERENCE NUMBER | NAME | UNITS | FORMAT | COMMENTS |
|---|---|---|---|---|
| 13 | EPLAT | $N/m^2$ | 2F10.0 | Complex Young's modulus of plate |
| 14 | GPLAT | $N/m^2$ | 2F10.0 | Complex Shear modulus of plate |

Coating Parameters

| | | |
|---|---|---|
| 15 | HCOAT | same as for plate |
| 16 | ROCOAT | |
| 17 | ECOAT | |
| 18 | GCOAT | |

Constrained Layer Parameters

| | | |
|---|---|---|
| 19 | HCONL | same as above |
| 20 | ROCONL | |
| 21 | ECONL | |
| 22 | GCONL | |

## C. INTERACTIVE INPUT

### INPUT DIALOGUE

When IAUTO=2, the input for PLTWAV becomes interactive via dialogue on the terminal. As can be seen from the parameter chart, no special formatting need be done by the user. Any value, be it integer, floating point, or exponential, will be accepted by the F10.0 format. The input sequence, which is in the same order as the data chart, can be seen in Appendix A-3.

### EDIT

After the parameters have all been entered utilizing the appropriate subroutines, the routine EDIT is called. This portion of the program has a twofold function. During the first run, EDIT is

used to check the input parameters; during subsequent runs, EDIT is used to change values to those desired next. Both of these functions are implemented in the same way. If there is a value that is incorrect, or needs to be changed for the next run, the user types the reference number to the left of the parameter name. This causes the name and present value to be displayed. The user will then type in the new value and return. At this point, the entire parameter list will be displayed again and the user will be asked if they are all correct. This sequence can be repeated until all the values are as desired, at which time, a 0 (zero) is entered to return to the main (see Appendix A-3).

END

The last I/O for the run comes at the end of all the computation, when the user is asked if another run is desired. If a '1' is entered, the program will return to EDIT, while a '0' will end PLTWAV (see Appendix A-3).

## D. AUTOMATIC INPUT

PLTWAV.DAT

To run in the automatic mode, the user must have previously created the input data file PLTWAV.DAT. This file is constructed so that exactly the same input sequence is used as when running interactively (refer to the data chart). Many runs can be accomplished by use of the reference numbers (ICHANG) and the repeat variable IRPT. The sequence is as follows:

IDAT
ITYPE
ISERCH
THMIN or FMIN
THMAX or FMAX

```
THINC or FINC
F or THETA
RO
C
HPLAT
ROPLAT
EPLAT
GPLAT
HCOAT    )
ROCOAT   )  Used only when there is a coating
ECOAT    )    i.e., ITYPE = 2, 3, or 4
GCOAT    )
HCONL    )
ROCONL   )  Used only when there is a constrained layer
ECONL    )    i.e., ITYPE = 4
GCONL    )
*****
IRPT        The repeat variable
              IRPT=0=>no more runs
                  =1=>another run
ICHANGE     The parameter REFERENCE NUMBER
VALUE       New value of the parameter
ICHANGE
VALUE
  :
ICHANGE=0=>return to main with all the data
IRPT
  :
```

The program will end when IRPT=0; and since ICHANG=0 to return from the last data set, the last two entries in the list will be zero. For example, let PLTWAV.DAT contain the following:

```
Example
    3
    1
    1
    0
    90
    .25
    64E3
    999.7
    1447.24
    .05
    7782.4
    21.6E10,0
    8.29E10,0
    1
    4
    32E3
    0
    0.
```

Then to begin with, both plot and numerical data are desired, so IDAT=3. It is a simple plate so ITYPE=1, and an angle search is to be implemented so ISERCH=1. The search will start at THMIN-0° and end at THMAX=90° with an increment of THINC=.25°, and the calculations will be made at the frequency F=64 kHz. The fluid density is RO=999.7 kg/m³, and the fluid sound speed is C=1447.24 m/sec. The plate thickness is HPLAT=.05m, and it has a density of ROPLAT=7782.4 kg/m³. Young's modulus is real and has a value

E=21.6E10, while the shear modulus is G=8.29E10. A repeat run is desired, so IRPT=1. The reference number 4 is for frequency, so the new frequency is F=32 kHz. There are no further changes, so ICHANG=0, and no more runs so IRPT=0 (see Appendix A-3).

## III. TRACE

### A. OVERALL

The program TRACE and its associated subroutines form a plotting package for use with the Textronix 4662 Interactive Plotter. Implemented to accept up to five different plot files and plot them with different line types, this package also allows for absolute scaling (linear only) and absolute size control (up to 10 x 15 inches). There is an option that will draw a legend on either side of the plot, but no labeling is performed.

### B. OUTPUT

The plot output from TRACE includes five different line types. The curves are traced by means of alternating arcs of light and dark, the arc length being specified by the array DASH in the subroutine SETDSH. Specifications for setting DASH can be found in the subroutine TKDASH (see Appendix B-4).

A legend can also be plotted by TRACE by the use of the subroutine LABEL. The legend can appear on either side of the plot, and at any distance from the top.

### C. INPUT

The input for TRACE is interactive via dialogue on the terminal. The user is asked how many curves are to be drawn, what the file specifications are, the scale limits, the label (legend) options, and to check the paper alignment.

LINE TYPE DESIGNATION

The plotter package can handle as many as five different files from any of the memory devices. The user types a number (1-5) when asked, and then types in the entire file specification for each curve. If a particular line type is not desired, a zero (0) is entered as the file specification. For example, if a solid line is not wanted, a zero is entered as the first file name.

SCALING

The user inputs minimum and maximum values for both axes. The scaling is computed on the basis of a 682 x 1023 grid. The entire grid can be as large at 10 x 15 inches and the axis limits can be of any value.

PAPER ALIGNMENT

When the user is asked to align the paper, he is told to enter an ordered pair. This ordered pair should be in terms of the scale, not the grid. Checking the corners seems to be sufficient.

LEGEND

The user is asked to specify the placement of the legend by right or left side, (0 means no legend), and placement below the normal position. The first is accomplished by typing R, L, or 0, while the latter is by typing an integer (0-585). The legend is normally 14 grid units down and 30 grid units inside the limits of the plot.

# IV. ALGORITHM DEVELOPMENT

## A. EQUATIONS

Begin by noting that what is wanted are radiation and reflection,

which are governed by the following:

Pressure radiated:

$$P_{rad} = \cos\theta/[1 + j\Omega\cos\theta],$$

Pressure reflected:

$$P_{ref} = 1-2/[1 + j\Omega\cos\theta]$$

where there is a different structural response for each physical structure. For a simple plate, the elastic response function $\Omega$ is:

$$\Omega = (k_o/\omega^2\rho)\left\{h\rho_s\omega^2 - gh\tilde{k}^2 + \tilde{k}^2(gh)^2/[D\tilde{k}^2 + gh - \rho_s h^3\omega^2/12]\right\}.$$

For a composite plate with welded interface, the elastic response function is:

$$\begin{aligned}\Omega = (k_o/\omega^2\rho)\Big\{&\omega^2(h\rho_s + h'\rho'_s) - \tilde{k}^2(g'h' + gh)\\ &+ \tilde{k}^2h^2[g^2 - (g')^2]/[\tilde{k}^2(D - \beta^2 D')\\ &+ h(g - \beta g') \; -(\beta\rho_s - \rho_s')\omega^2h^2h'/12]\Big\}.\end{aligned}$$

For a composite structure with slipping interface:

$$\begin{aligned}\Omega = (k_o/\omega^2\rho)\Big\{&\omega^2(h\rho_s + h'\rho'_s) - \tilde{k}^2(gh + g'h')\\ &+ \tilde{k}^2(gh)^2/[\tilde{k}^2 D + gh - \omega^2\rho_s h^3/12]\\ &+ \tilde{k}^2(g'h')^2/[\tilde{k}^2 D' + g'h' - \omega^2\rho_s' h'^3/12]\Big\}.\end{aligned}$$

For a constrained layer, the result is:

$$\Omega = (k_o/\omega^2\rho)\Big\{\omega^2(h\rho_s + h'\rho'_s + h''\rho''_s) - \tilde{k}^2(gh + g'h')$$

$$+ \tilde{k}^2h^2[g^2 - (g')^2]/[\tilde{k}^2\{D - \beta^2D' + (h/h'')D''\}$$

$$+ h(g - \beta g') - (\beta\rho_s - \rho_s')\omega^2h^2h'/12]\Big\}.$$

To do these computations, several secondary parameters are needed:

$$\kappa = (0.87 + 1.12\nu)/(1 + \nu)$$

$$g = \kappa^2G$$

$$D = Eh^3/[12(1 - \nu^2)]$$

$$\omega^2 = (2\pi f)^2$$

$$\beta = h/h'$$

$$k_o = 2\pi f/c$$

$$\tilde{k} = k_o\sin\theta$$

## B. NAME LIST

A name list is required to keep track of the parameters.

| Program Name | Generic Name |
|---|---|
| THETA | $\theta$ |
| THMIN | $\theta$min |
| THMAX | $\theta$max |
| THINC | $\theta$increment |
| F | frequency |
| FMIN | fmin |
| FMAX | fmax |
| FINC | fincrement |

| Program Name | Generic Name |
|---|---|
| PI | $\pi$ |
| F2 | $\omega^2$ (= angular frequency)$^2$ |
| CX1 | 1 |
| CX2 | 2 |
| CXJ | $j = \sqrt{-1}$ |
| C | fluid sound speed c |
| RO | fluid density $\rho$ |
| ROPLAT | $\rho_s$ - density of plate |
| ROCOAT | $\rho_s'$ - coat density |
| ROCONL | $\rho_s''$ - constrained layer density |
| H | h - thickness (general) |
| HPLAT | h - thickness of plate |
| HCOAT | h' - coat thickness |
| HCONL | h" - constrained layer thickness |
| G | G - shear modulus (general) |
| GPLAT | G - shear modulus of plate |
| GCOAT | G' - shear modulus of coat |
| GCONL | G" - shear modulus of constrained layer |
| SG | $\kappa^2$G modified shear (general) |
| GP | g - modified shear of plate |
| GC | g' - modified shear of coat |
| GL | g" - modified shear of constrained layer |
| E | E - Young's Modulus (general) |
| EPLAT | E - Young's Modulus of plate |
| ECOAT | E' - Young's Modulus of coat |
| ECONL | E" - Young's Modulus of constrained layer |
| BETA | $\beta$ |
| KO | $k_o$ |
| K | k |
| KAPA | $\kappa$ - (general) |

| Program Name | Generic Name |
|---|---|
| KAPAPL | $\kappa$ - of plate |
| KAPACO | $\kappa'$ - of coat |
| KAPACL | $\kappa''$ - of constrained layer |
| D | D (general) flexural rigidity |
| DPLAT | D - of plate |
| DCOAT | D' - of coat |
| DCONL | D" - of constrained layer |
| V | $\nu$ - (general) Poisson's ratio |
| VPLAT | $\nu$ - of plate |
| VCOAT | $\nu'$ - of coat |
| VCONL | $\nu''$ - of constrained layer |
| RAD | $P_{rad}$ |
| REF | $P_{ref}$ |
| OMEGA | $\Omega$ - elastic response function |

## C. FORTRAN VERSIONS

With these names, the FORTRAN versions become (in general):

```
RAD = COS(THETA)/[CX1 + CXJ * OMEGA * COS(THETA)]
REF = CX1 - CX2/[CX1 + CXJ * OMEGA * COS(THETA)]
V = [E/(CX2 * G)]  - 1
KAPA = (.87 + 1.12V)/(1 + V)
SG = (KAPA) ** 2 * G
D = E * (H ** 3)/[12 * (1 - V ** 2)]
F2 = (2 * PI * F) ** 2
KO = 2 * PI * F/C
K = KO * SIN(THETA)
```

Wherever possible, constants that need to be complex are specified,

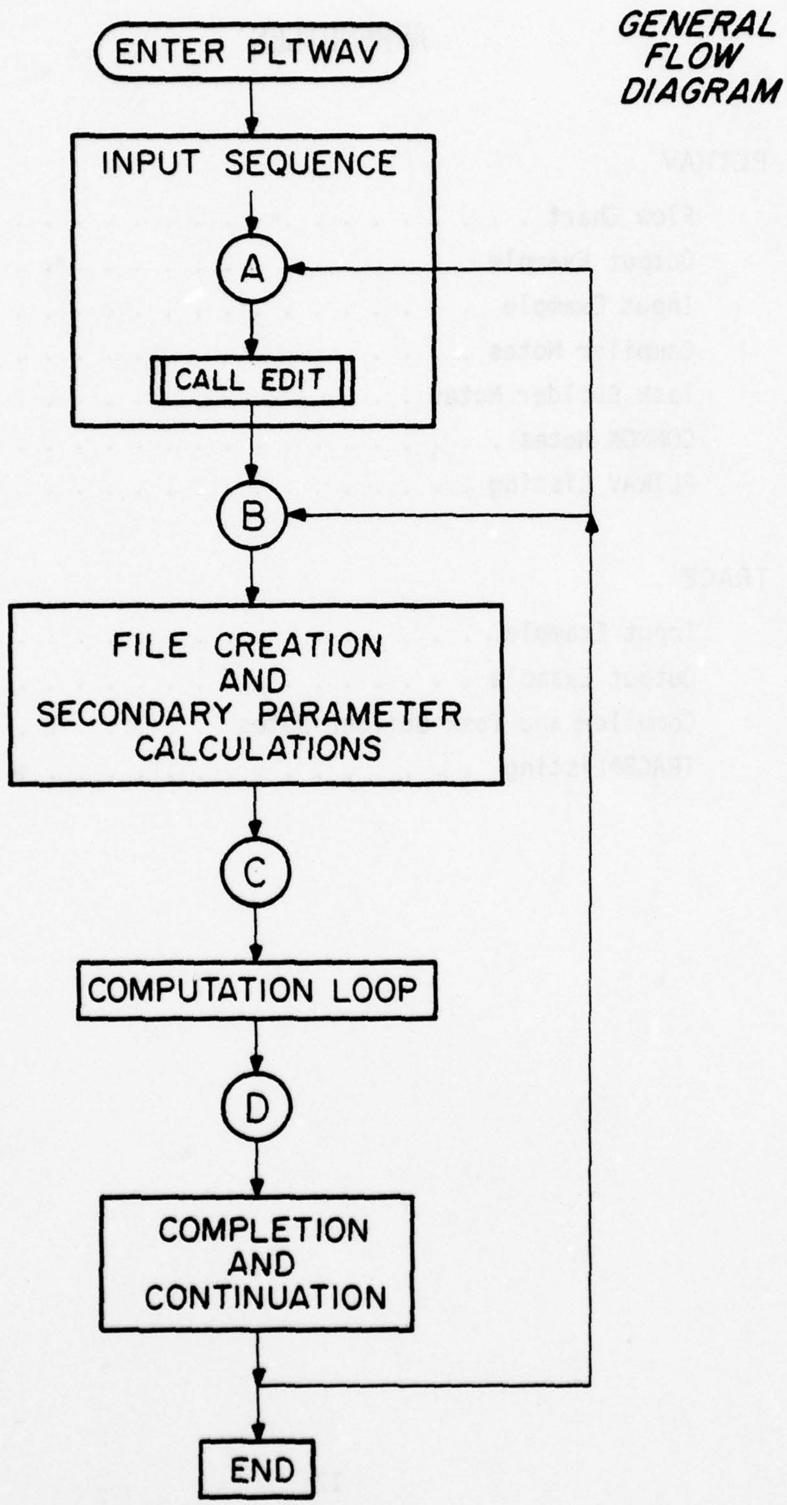
such as CMPLX(12.,0.). Each OMEGA is computed in a separate subroutine. The simple plate Ω is computed in OMEGA1, composite with welded interface in OMEGA2, and so on (see Appendix A-7).

# APPENDICES

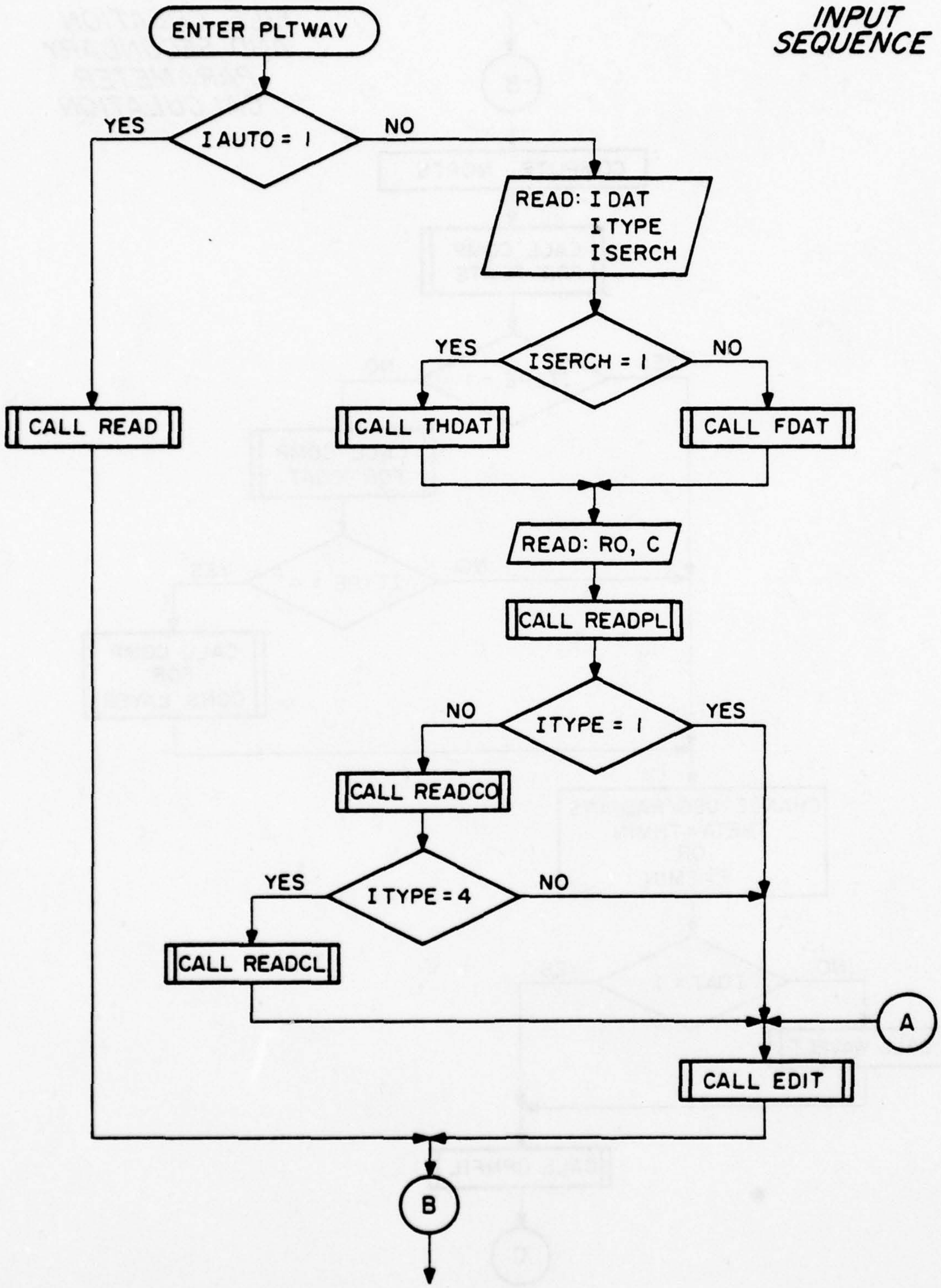
A. PLTWAV



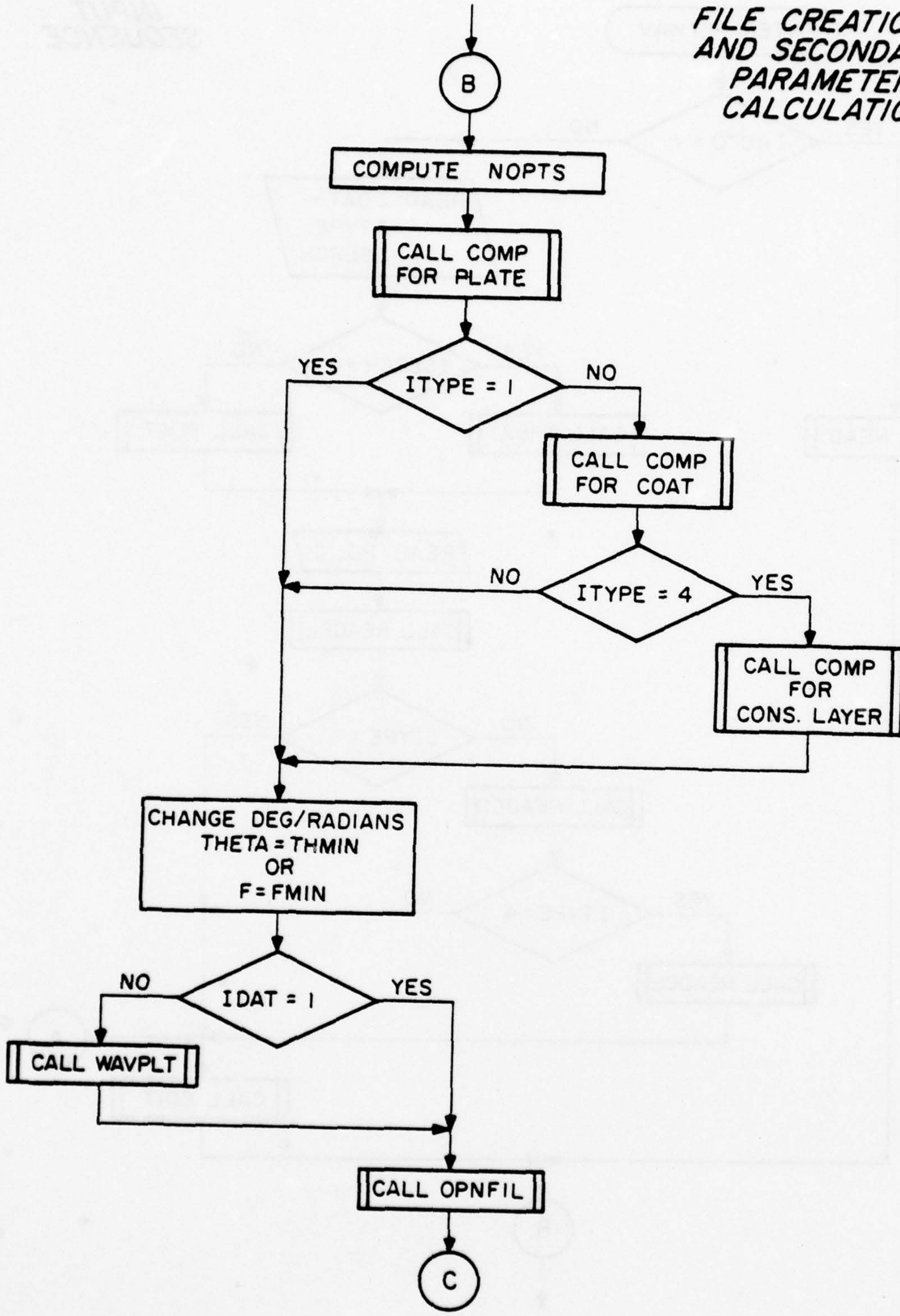
B. TRACE

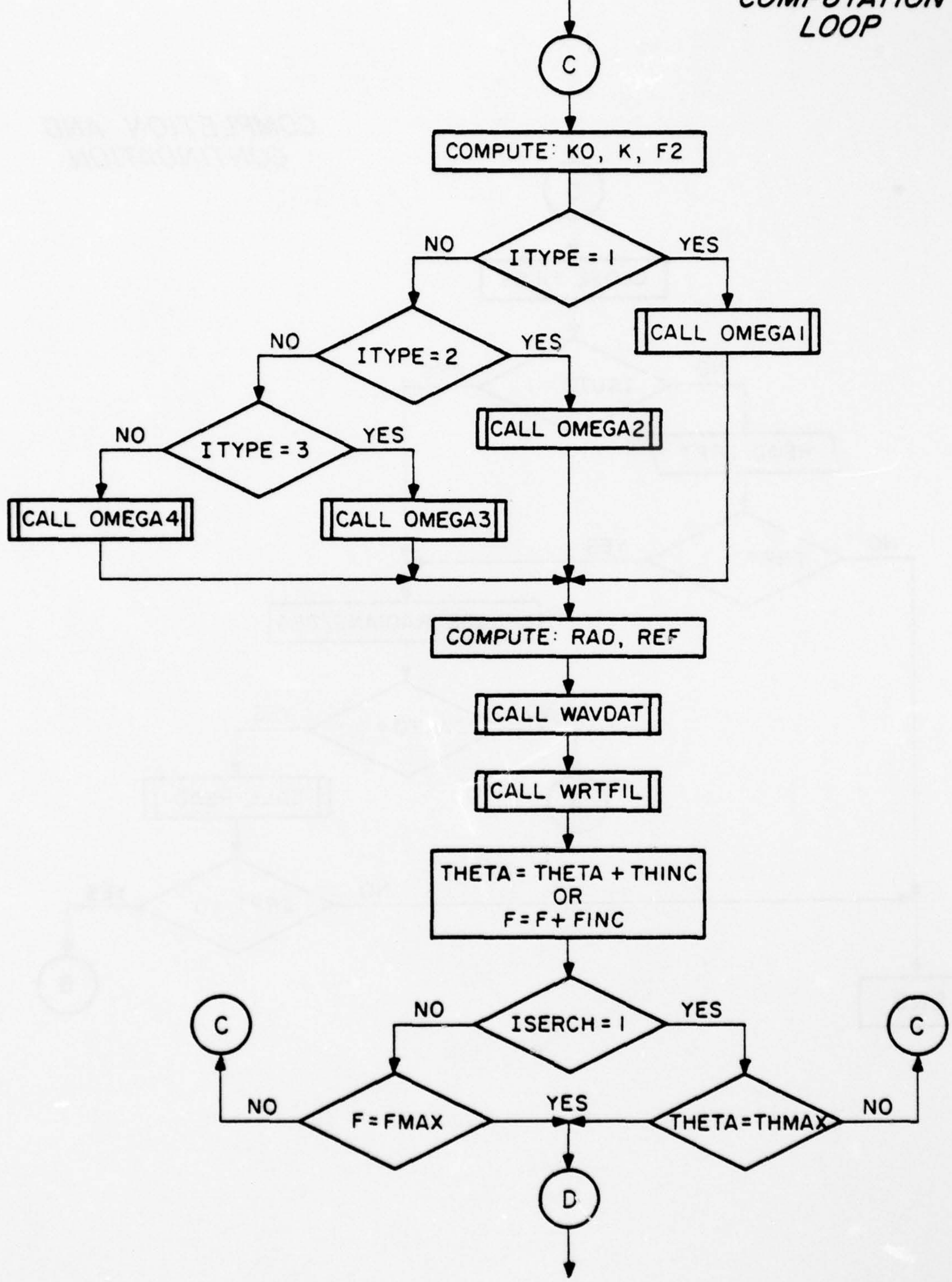

GENERAL
FLOW
DIAGRAM
ENTER PLTWAV
INPUT SEQUENCE
A
CALL EDIT
B
FILE CREATION
AND
SECONDARY PARAMETER
CALCULATIONS
C
COMPUTATION LOOP
D
COMPLETION
AND
CONTINUATION
END

A 1

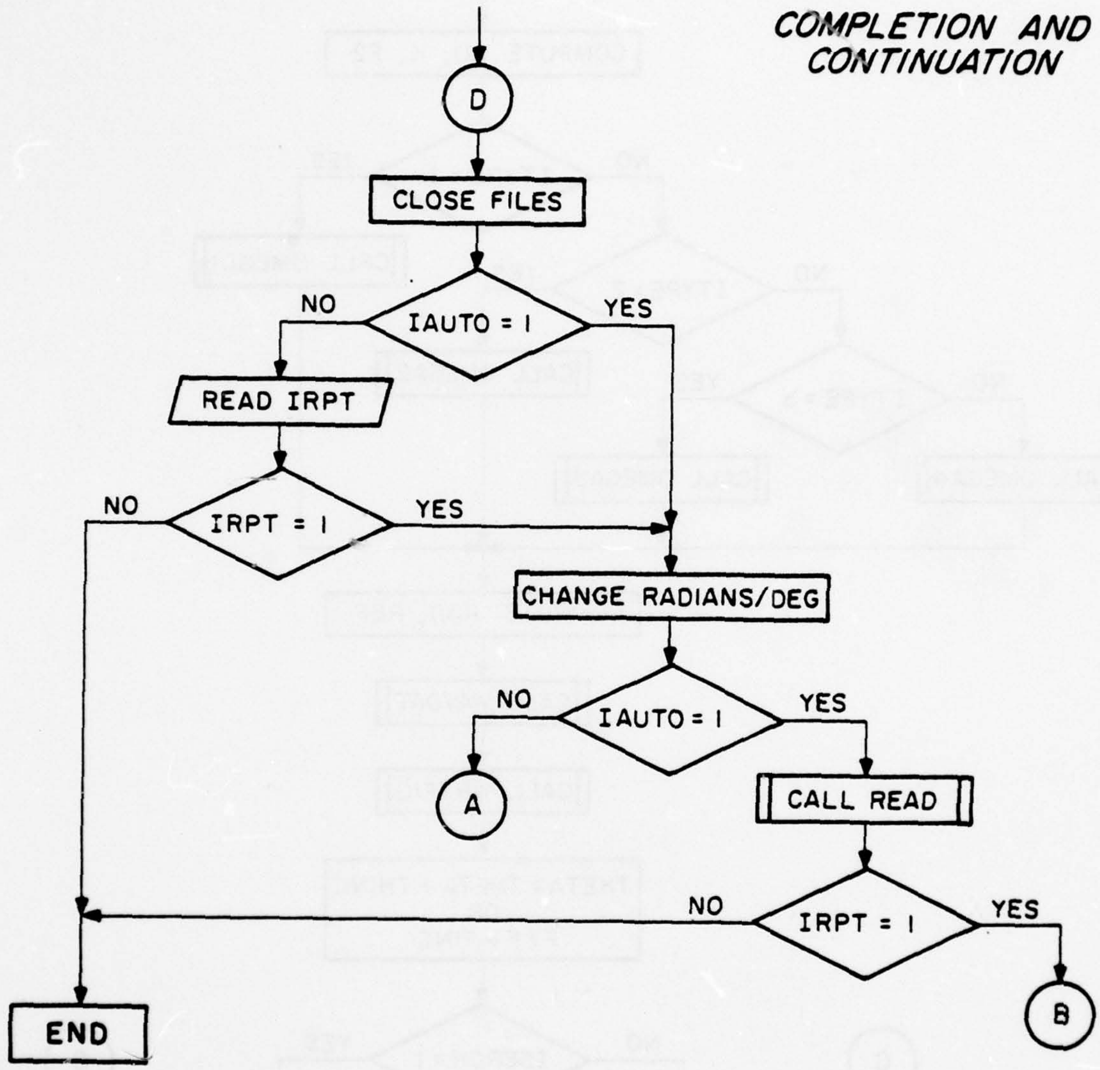

INPUT
SEQUENCE
ENTER PLTWAV
IAUTO = 1
YES
NO
READ: IDAT
ITYPE
ISERCH
ISERCH = 1
YES
NO
CALL READ
CALL THDAT
CALL FDAT
READ: RO, C
CALL READPL
ITYPE = 1
NO
YES
CALL READCO
ITYPE = 4
YES
NO
CALL READCL
A
CALL EDIT
B

*FILE CREATION AND SECONDARY PARAMETER CALCULATION*




COMPUTATION
LOOP
C
COMPUTE: KO, K, F2
ITYPE = 1
NO
YES
CALL OMEGA1
ITYPE = 2
NO
YES
CALL OMEGA2
ITYPE = 3
NO
YES
CALL OMEGA4
CALL OMEGA3
COMPUTE: RAD, REF
CALL WAVDAT
CALL WRTFIL
THETA = THETA + THINC
OR
F = F + FINC
ISERCH = 1
NO
YES
F = FMAX
THETA = THMAX
NO
YES
NO
C
C
D

*COMPLETION AND CONTINUATION*



# A-2

## PLTWAV OUTPUT EXAMPLE

```
        WHAT FOLLOWS IS AN EXAMPLE OF THE NUMERICAL OUTPUT GENERATED
BY 'PLTWAV'.  THIS SET OF DATA REPRESENTS AN EMISSION ANGLE SEARCH
FROM 12.27 TO 12.29 DEGREES FOR A SIMPLE STEEL PLATE.

SIMPLE PLATE

SEARCH THROUGH EMISSION ANGLE

INPUT PARAMETERS:           PLATE                              COATING                          CONSTRAINED LAYER

                     REAL          COMPLEX            REAL          COMPLEX            REAL          COMPLEX

DENSITY        RO= 0.778240E+04                     0.000000E+00                     0.000000E+00                 KG/METER**3
THICKNESS       H= 0.500000E-01                     0.000000E+00                     0.000000E+00                 METERS
SHEAR MODULUS   G= 0.829000E+11 0.000000E+00        0.000000E+00 0.000000E+00        0.000000E+00 0.000000E+00  NT/SQ METER
YOUNGS MOD.     E= 0.216000E+12 0.000000E+00        0.000000E+00 0.000000E+00        0.000000E+00 0.000000E+00  NT/SQ METER
POISSONS RATIO  V= 0.302774E+00 0.000000E+00        0.000000E+00 0.000000E+00        0.000000E+00 0.000000E+00

COMPUTED PARAMETERS:

MODIFIED SHEAR  G= 0.714078E+11 0.000000E+00        0.000000E+00 0.000000E+00        0.000000E+00 0.000000E+00  NT/SQ METER
FLEX. REGIDITY  D= 0.247708E+07 0.000000E+00        0.000000E+00 0.000000E+00        0.000000E+00 0.000000E+00  NT METERS
TIMOSHENKOS  KAPA= 0.928102E+00 0.000000E+00        0.000000E+00 0.000000E+00        0.000000E+00 0.000000E+00

FLUID PARAMETERS:

FLUID SOUND SPEED = 0.144724E+04 METERS/SEC
FLUID DENSITY     = 0.999700E+03 KG/METER**3

ROMEGA=>THE REAL PART OF OMEGA
IOMEGA=>THE IMAGINARY PART OF OMEGA
MOMEGA=>THE MAGNITUDE OF OMEGA
AOMEGA=>THE PHASE OF OMEGA
MREF=>THE MAGNITUDE OF REFLECTION
AREF=>THE PHASE OF THE REFLECTION
MRAD=>THE MAGNITUDE OF RADIATION
ARAD=>THE PHASE OF THE RADIATION
```

| THETA | FREQ | ROMEGA | IOMEGA | MOMEGA | AOMEGA | MREF | AREF | MRAD | ARAD |
|---|---|---|---|---|---|---|---|---|---|
| 0.12270E+02 | 0.64000E+05 | 0.19750E+01 | 0.00000E+00 | 0.19750E+01 | 0.00000E+00 | 0.10000E+01 | 0.95617E+00 | 0.44957E+00 | 0.17891E+03 |
| 0.12271E+02 | 0.64000E+05 | 0.18275E+01 | 0.00000E+00 | 0.18275E+01 | 0.00000E+00 | 0.10000E+01 | 0.10210E+01 | 0.47744E+00 | 0.17894E+03 |
| 0.12272E+02 | 0.64000E+05 | 0.16792E+01 | 0.00000E+00 | 0.16792E+01 | 0.00000E+00 | 0.10000E+01 | 0.10947E+01 | 0.50852E+00 | 0.17898E+03 |
| 0.12273E+02 | 0.64000E+05 | 0.15307E+01 | 0.00000E+00 | 0.15307E+01 | 0.00000E+00 | 0.10000E+01 | 0.11786E+01 | 0.54309E+00 | 0.17902E+03 |
| 0.12274E+02 | 0.64000E+05 | 0.13817E+01 | 0.00000E+00 | 0.13817E+01 | 0.00000E+00 | 0.10000E+01 | 0.12750E+01 | 0.58159E+00 | 0.17907E+03 |
| 0.12275E+02 | 0.64000E+05 | 0.12323E+01 | 0.00000E+00 | 0.12323E+01 | 0.00000E+00 | 0.10000E+01 | 0.13861E+01 | 0.62428E+00 | 0.17912E+03 |
| 0.12276E+02 | 0.64000E+05 | 0.10820E+01 | 0.00000E+00 | 0.10820E+01 | 0.00000E+00 | 0.10000E+01 | 0.15151E+01 | 0.67144E+00 | 0.17919E+03 |
| 0.12277E+02 | 0.64000E+05 | 0.93195E+00 | 0.00000E+00 | 0.93195E+00 | 0.00000E+00 | 0.10000E+01 | 0.16643E+01 | 0.72246E+00 | 0.17926E+03 |
| 0.12278E+02 | 0.64000E+05 | 0.78088E+00 | 0.00000E+00 | 0.78088E+00 | 0.00000E+00 | 0.10000E+01 | 0.18380E+01 | 0.77682E+00 | 0.17935E+03 |

| THETA | FREQ | ROMEGA | IOMEGA | MOMEGA | AOMEGA | MREF | AREF | MRAD | ARAD |
|---|---|---|---|---|---|---|---|---|---|
| 0.12279E+02 | 0.64000E+05 | 0.62945E+00 | 0.00000E+00 | 0.62945E+00 | 0.00000E+00 | 0.10000E+01 | 0.20388E+01 | 0.83230E+00 | 0.17945E+03 |
| 0.12280E+02 | 0.64000E+05 | 0.47777E+00 | 0.00000E+00 | 0.47777E+00 | 0.00000E+00 | 0.10000E+01 | 0.22681E+01 | 0.88539E+00 | 0.17956E+03 |
| 0.12281E+02 | 0.64000E+05 | 0.32552E+00 | 0.00000E+00 | 0.32552E+00 | 0.00000E+00 | 0.10000E+01 | 0.25257E+01 | 0.93115E+00 | 0.17969E+03 |
| 0.12282E+02 | 0.64000E+05 | 0.17257E+00 | 0.00000E+00 | 0.17257E+00 | 0.00000E+00 | 0.10000E+01 | 0.28075E+01 | 0.96351E+00 | 0.17983E+03 |
| 0.12283E+02 | 0.64000E+05 | 0.19501E-01 | 0.00000E+00 | 0.19501E-01 | 0.00000E+00 | 0.10000E+01 | 0.31035E+01 | 0.97693E+00 | 0.17998E+03 |
| 0.12284E+02 | 0.64000E+05 | -0.13438E+00 | 0.00000E+00 | 0.13438E+00 | 0.31416E+01 | 0.10000E+01 | 0.17712E+03 | 0.96879E+00 | 0.13056E+00 |
| 0.12285E+02 | 0.64000E+05 | -0.28862E+00 | 0.00000E+00 | 0.28862E+00 | 0.31416E+01 | 0.10000E+01 | 0.17741E+03 | 0.94042E+00 | 0.27487E+00 |
| 0.12286E+02 | 0.64000E+05 | -0.44356E+00 | 0.00000E+00 | 0.44356E+00 | 0.31416E+01 | 0.10000E+01 | 0.17768E+03 | 0.89652E+00 | 0.40896E+00 |
| 0.12287E+02 | 0.64000E+05 | -0.59853E+00 | 0.00000E+00 | 0.59853E+00 | 0.31416E+01 | 0.10000E+01 | 0.17792E+03 | 0.84345E+00 | 0.52918E+00 |
| 0.12288E+02 | 0.64000E+05 | -0.75444E+00 | 0.00000E+00 | 0.75444E+00 | 0.31416E+01 | 0.10000E+01 | 0.17813E+03 | 0.78649E+00 | 0.63523E+00 |

A-3

# RUNNING PLTWAV

## - INTERACTIVE -

```
MCR>RUN PLTWAV )

HOW DO YOU WISH TO RUN?

1 AUTOMATICALLY
2 INTERACTIVELY

 TYPE 1 OR 2   2 )

WHAT TYPE OF DATA OUTPUT WOULD YOU LIKE?

 1  NUMERICAL DATA FILES
 2  PLOT FILES
 3  BOTH

 TYPE 1,2, OR 3   2 )

WHAT TYPE OF STRUCTURE DO YOU WANT TO ANALYZE?

 1 SIMPLE PLATE
 2 COMPOSITE WITH WELDED INTERFACE
 3 COMPOSITE WITH SLIPPING INTERFACE
 4 CONSTRAINED LAYER-WELDED INTERFACE

TYPE 1, 2, 3,OR 4   4 )

WHAT TYPE OF SEARCH?

 1 THROUGH EMISSION ANGLE
 2 THROUGH FREQUENCY

TYPE 1 OR 2   1 )
```

Note: 1), All underlined portions are User supplied
2), ) means 'RETURN'

```
SOME INFORMATION IS NEEDED.

THE PARAMETERS CAN BE INPUT USING ANY FORMAT.
THE COMPLEX PARAMETERS CAN BE SEPERATED INTO
REAL AND IMAGINARY PARTS BY A COMMA.

MINIMUM THETA=              0 )
MAXIMUM THETA=              90 )
THETA INCREMENT=            .25 )
FREQUENCY=                  2E3)
FLUID DENSITY=              999.7 )
FLUID SOUND SPEED=          1447.24 )
THICKNESS OF PLATE=         .05 )
DENSITY OF PLATE=           7782.4 )
YOUNGS MOD. OF PLATE=       21.6E10 )
SHEAR MOD. OF PLATE=        8.29E10 )
THICKNESS OF COATING=       .05 )
DENSITY OF COATING=         1310 )
YOUNGS MOD. OF COATING=     7.102E8,4.895E8 )
SHEAR MOD. OF COATING=      2.3673E8,1.6317E8 )
THICKNESS OF CONS. LAYER=          .002 )
DENSITY OF CONS. LAYER=            7782.4 )
YOUNGS MOD. OF CONS. LAYER=        21.6E10 )
SHEAR MOD. OF CONS. LAYER=         8.29E10)
```

**Note: 1), All underlined portions are User supplied**

**2), ) means 'RETURN'**

```
 1 THETA MIN=                      0.000000
 2 THETA MAX=                     90.000000
 3 THETA INCREMENT=                0.250000
 4 FREQUENCY=                      0.200000E+04
 9 FLUID SOUND SPEED=              0.144724E+04
 10 FLUID DENSITY=                 0.999700E+03
 11 PLATE THICKNESS=               0.050000
 12 PLATE DENSITY=                 0.778240E+04
 13 YOUNGS MOD. OF PLATE=          0.216000E+12 0.000000E+00
 14 SHEAR MOD. OF PLATE=           0.829000E+11 0.000000E+00
 15 COAT THICKNESS=                0.050000
 16 COAT DENSITY=                  0.131000E+04
 17 YOUNGS MOD. OF COAT=           0.710200E+09 0.489500E+09
 18 SHEAR MOD. OF COAT=            0.236730E+09 0.163170E+09
 19 THICK. OF CONS. LAYER=         0.002000
 20 DENSITY OF CONS.LAYER =        0.778240E+04
 21 YOUNGS OF CONS. LAYER =        0.216000E+12 0.000000E+00
 22 SHEAR OF CONS. LAYER =         0.829000E+11 0.000000E+00
 23  IDAT=                         2
 24  ITYPE=                        4
 25  ISERCH=                       1

IF THESE ARE CORRECT TYPE 0
TO MAKE A CORRECTION, TYPE THE NUMBER
 TO THE LEFT OF THE INCORRECT PARAMETER
0)
```

**Note: 1), All underlined portions are User supplied**

**2), ) means 'RETURN'**

```
DO YOU WANT TO REPEAT THE SEARCH WITH
 A CHANGE IN VARIABLES?

 TYPE 1 FOR YES, 0 FOR NO  1 ⤶

 1 THETA MIN=                   0.000000
 2 THETA MAX=                  90.000000
 3 THETA INCREMENT=             0.250000
 4 FREQUENCY=                   0.200000E+04
 9 FLUID SOUND SPEED=           0.144724E+04
 10 FLUID DENSITY=              0.999700E+03
 11 PLATE THICKNESS=            0.050000
 12 PLATE DENSITY=              0.778240E+04
 13 YOUNGS MOD. OF PLATE=       0.216000E+12 0.000000E+00
 14 SHEAR MOD. OF PLATE=        0.829000E+11 0.000000E+00
 15 COAT THICKNESS=             0.050000
 16 COAT DENSITY=               0.131000E+04
 17 YOUNGS MOD. OF COAT=        0.710200E+09 0.489500E+09
 18 SHEAR MOD. OF COAT=         0.236730E+09 0.163170E+09
 19 THICK. OF CONS. LAYER=      0.002000
 20 DENSITY OF CONS.LAYER =     0.778240E+04
 21 YOUNGS OF CONS. LAYER =     0.216000E+12 0.000000E+00
 22 SHEAR OF CONS. LAYER =      0.829000E+11 0.000000E+00
 23  IDAT=                      2
 24  ITYPE=                     4
 25  ISERCH=                    1

IF THESE ARE CORRECT TYPE 0
TO MAKE A CORRECTION, TYPE THE NUMBER
 TO THE LEFT OF THE INCORRECT PARAMETER
19⤶
 19 THICK. OF CONS. LAYER=  0.002000  .0005 ⤶
```

**Note: 1), All underlined portions are User supplied**

**2), ⤶ means 'RETURN'**

```
 1 THETA MIN=                   0.000000
 2 THETA MAX=                  90.000000
 3 THETA INCREMENT=             0.250000
 4 FREQUENCY=                   0.200000E+04
 9 FLUID SOUND SPEED=           0.144724E+04
 10 FLUID DENSITY=              0.999700E+03
 11 PLATE THICKNESS=            0.050000
 12 PLATE DENSITY=              0.778240E+04
 13 YOUNGS MOD. OF PLATE=       0.216000E+12 0.000000E+00
 14 SHEAR MOD. OF PLATE=        0.829000E+11 0.000000E+00
 15 COAT THICKNESS=             0.050000
 16 COAT DENSITY=               0.131000E+04
 17 YOUNGS MOD. OF COAT=        0.710200E+09 0.489500E+09
 18 SHEAR MOD. OF COAT=         0.236730E+09 0.163170E+09
 19 THICK. OF CONS. LAYER=      0.000500
 20 DENSITY OF CONS.LAYER =     0.778240E+04
 21 YOUNGS OF CONS. LAYER =     0.216000E+12 0.000000E+00
 22 SHEAR OF CONS. LAYER =      0.829000E+11 0.000000E+00
 23  IDAT=                      2
 24  ITYPE=                     4
 25  ISERCH=                    1

IF THESE ARE CORRECT TYPE 0
TO MAKE A CORRECTION, TYPE THE NUMBER
 TO THE LEFT OF THE INCORRECT PARAMETER
0 )



DO YOU WANT TO REPEAT THE SEARCH WITH
 A CHANGE IN VARIABLES?

 TYPE 1 FOR YES, 0 FOR NO  0 )
**** PLTWAV IS NOW FINISHED ****
```

Note: 1), All underlined portions are User supplied

2), ) means 'RETURN'

## A-3 CONT.

### RUNNING PLTWAV

### - AUTOMATIC -

```
MCR>RUN PLTWAV )

HOW DO YOU WISH TO RUN?

1 AUTOMATICALLY
2 INTERACTIVELY

 TYPE 1 OR 2   1 )


RUN NUMBER  1 IS COMPLETED
RUN NUMBER  2 IS COMPLETED
RUN NUMBER  3 IS COMPLETED
RUN NUMBER  4 IS COMPLETED
RUN NUMBER  5 IS COMPLETED
RUN NUMBER  6 IS COMPLETED
**** PLTWAV IS NOW FINISHED ****
```

Note: 1), All underlined portions are User supplied

2), ) means 'RETURN'

A-4

## PLTWAV COMPILATION

THE COMPILER FOR FORTRAN 4 PLUS ON THE PDP 11/45 WITH THE RSX 11-D SYSTEM IS RUN USING THE 'F4P' COMMAND. THIS OPERATION TAKES THE SOURCE FILE AND CREATES AN OBJECT CODE IMAGE WITH THE SAME NAME. WHAT FOLLOWS IS A FILE CALLED 'PLTWAV.F4P', AND IS THE COMMAND FILE FOR COMPILING ALL OF THE ROUTINES USED BY 'PLTWAV'. TO INDICATE THIS FILE TO THE COMPILER, USE THE COMMAND STRING: '@PLTWAV.F4P' AFTER THE 'F4P' COMMAND HAS CALLED THE COMPILER. FOR EXAMPLE:

```
CONTROL C
MCR>F4P
F4P>@PLTWAV.F4P
F4P>CONTROL Z TO EXIT
```

```
PLTWAV=PLTWAV/-SP/-RO/TR/CK
TKCLER=TKCLER/-RO/-SP/TR/CK
READ=READ/-RO/-SP/CK/TR
FDAT=FDAT/-RO/-SP/TR/CK
THDAT=THDAT/-RO/-SP/TR/CK
EDIT=EDIT/-RO/-SP/TR/CK
READPL=READPL/-RO/-SP/TR/CK
READCO=READCO/-RO/-SP/TR/CK
READCL=READCL/-RO/-SP/TR/CK
COMP=COMP/-RO/-SP/TR/CK
WAVPLT=WAVPLT/-RO/-SP/TR/CK
HEADER=HEADER/-RO/-SP/TR/CK
OPNFIL=OPNFIL/-RO/-SP/TR/CK
WAVDAT=WAVDAT/-RO/-SP/TR/CK
WRTFIL=WRTFIL/-RO/-SP/TR/CK
OMEGA1=OMEGA1/-RO/-SP/TR/CK
OMEGA2=OMEGA2/-RO/-SP/TR/CK
OMEGA3=OMEGA3/-RO/-SP/TR/CK
OMEGA4=OMEGA4/-RO/-SP/CK/TR
```

Note: 1), All underlined portions are User supplied

2), ) means 'RETURN'

# A-5

## PLTWAV TASK BUILDING

THE TASK BUILDING OPERATION ON THE RSX 11-D SYSTEM IS USED TO LINK THE OBJECT FILES THAT HAVE BEEN CREATED BY THE COMPILER. THIS ALLOWS THE USER TO OVERLAY THE ROUTINES AS OPPOSED TO THE MORE USUAL BATCH PROCESSING, INCREASING THE SPEED OF THE PROGRAM AND REDUCING ITS MEMORY REQUIREMENTS. WHAT FOLLOWS IS 1) THE COMMAND STRING FOR THE TKB OPPERATION AND 2) THE COMMAND FILE 'PLTWAV.TKB' THAT THE STRING DIRECTS THE TASK BUILDER TO.

```
CONTROL C )
MCR>TKB )
TKB>@PLTWAV.TKB )
TKB>CONTROL Z )TO EXIT
```

```
PLTWAV,PLTWAV/SH/-SP=PLTWAV,TKCLER,FDAT,THDAT,EDIT,
READCO,READPL,COMP,WAVPLT,HEADER,OPNFIL,READCL,
WAVDAT,WRTFIL,OMEGA1,OMEGA2,OMEGA3,OMEGA4,READ
/
LIBR=OTSCOR:RO
UNITS=13
ACTFIL=13
ASG=TI:1:2
ASG=SY:3:4:5:7:9:11:12:13
ASG=SY:6:8:10
POOL=50
STACK=512
/
```

**Note: 1), All underlined portions are User supplied**

**2), ) means 'RETURN'**

## A-6

## PLTWAV COMMON

THE COMMON SECTION FOR 'PLTWAV' IS RATHER LARGE. FOR THIS REASON, A FILE CALLED 'PLTWAV.COM' WAS CREATED AND THE 'INCLUDE' STATEMENT WAS USED IN THE ROUTINES REQUIRING THE COMMON. WHAT FOLLOWS IS THE FILE 'PLTWAV.DAT':

```
      COMMON IDAT,ITYPE,ISERCH,IRPT
      COMMON FMIN,FMAX,FINC,THETA
      COMMON THMIN,THMAX,THINC,F
      COMMON RO,C,HPLAT,ROPLAT,EPLAT,GPLAT,VPLAT,DPLAT,KAPAPL
      COMMON HCOAT,ROCOAT,ECOAT,GCOAT,VCOAT,DCOAT,KAPACO
      COMMON HCONL,ROCONL,ECONL,GCONL,VCONL,DCONL,KAPACL
      COMMON WAVDT(10),OMEGA
C
      COMPLEX EPLAT,GPLAT,VPLAT,DPLAT,KAPAPL,GP
      COMPLEX ECOAT,GCOAT,VCOAT,DCOAT,KAPACO,GC
      COMPLEX ECONL,GCONL,VCONL,DCONL,KAPACL,GL
      COMPLEX OMEGA,CXDUM,CXCOS,CX1,CX2,CXJ,REF,RAD
C
      REAL K,KO
```

# A-7

## PLTWAV LISTING

```
C  WRITTEN BY MARTIN D. RING AT THE NRL-USRD.  AUG. 22,1978
C  THIS IS THE MAIN PROGRAM PLTWAV.FTN
C
C THE SUBROUTINES CALLED ARE LISTED HERE:
C
C       READ FOR I/O WHEN THE AUTOMATIC OPTION IS USED
C
C       TKCLER CLEARS THE CRT SCREEN
C
C       FDAT  TAKES INPUT DATA WHEN FREQUENCY IS AN INDEPENDENT
C             VARIABLE
C
C       THDAT WHEN THETA--THE ANGLE OF EMISSION--IS AN IND. VARIABLE
C
C       READCO  INPUT DATA PERTAINING TO THE COATING
C
C       READPL  INPUT DATA PERTAINING TO THE PLATE
C
C       READCL  INPUT DATA PERTAINING TO THE CONSTRAINED LAYER
C
C       EDIT TO CHECK THE INPUT SEQUENCE
C
C       COMP  TO COMPUTE MATERIAL PARAMETERS
C
C       WAVPLT TO OPEN THE PLOT FILES USING HEADER
C
C       OPNFIL TO OPEN THE DATA AND PLOT FILES
C
C       OMEGA1 TO COMPUTE OMEGA FOR SIMPLE PLATE PROBLEMS
C
C       OMEGA2 TO COMPUTE OMEGA FOR WELDED INTERFACE
C
C       OMEGA3 TO COMPUTE OMEGA FOR SLIPPING INTERFACE
C
C       OMEGA4 TO COMPUTE OMEGA FOR CONSTRAINED LAYER
C
C       WAVDAT TO FILL AN ARRAY-WAVDT(10)
C
C       WRTFIL TO WRITE PARTS OF WAVDT INTO FILES
C
C  A LIST OF PARAMETERS AND THEIR NAMES FOLLOWS:
C
C   FREQUENCY. . . . . . . . . . . . . . . . . . . . .F HERTZ
C   FLUID SOUND SPEED. . . . . . . . . . . . . . . . .C METERS/SEC
C   SHEAR MODULUS OF PLATE . . . . . . . . . . . . . .GPLAT NT/SQ METER
C                    COATING . . . . . . . . . . . . .GCOAT
C                    CONSTRAINED LAYER . . . . . . . .GCONL
C   MODIFIED SHEAR MODULUS OF PLATE. . . . . . . . . .GP
C                             COATING. . . . . . . . .GC
C                             CONS. LAYER. . . . . . .GL
C   DENSITY OF FLUID . . . . . . . . . . . . . . . . .RO KG/METER CUBED
C              PLATE . . . . . . . . . . . . . . . . .ROPLAT
C              COATING . . . . . . . . . . . . . . . .ROCOAT
C              CONSTRAINED LAYER . . . . . . . . . . .ROCONL
C   THICKNESS OF PLATE . . . . . . . . . . . . . . . .HPLAT METERS
C                COATING . . . . . . . . . . . . . . .HCOAT
C                CONSTRAINED LAYER . . . . . . . . . .HCONL
C   YOUNG'S MODULUS OF PLATE . . . . . . . . . . . . .EPLAT NT/METER SQ.
C                      COATING . . . . . . . . . . . .ECOAT
C                      CONSTRAINED LAYER . . . . . . .ECONL
C   POISSONS RATIO OF PLATE. . . . . . . . . . . . . .VPLAT
C                     COATING. . . . . . . . . . . . .VCOAT
C                     CONSTRAINED LAYER. . . . . . . .VCONL
C   EMISSION ANGLE. . . . . . . . . . . . . . . . . .THETA DEG
C   ELASTIC RESPONSE FUNCTION. . . . . . . . . . . . .OMEGA
```

```
C    REFLECTED SOUND. . . . . . . . . . . . . . . . . .REF
C    RADIATED SOUND . . . . . . . . . . . . . . . . . .RAD
C
C
C TERMINAL WRITE=LUN 1
C TERMINAL READ=LUN 2
C OTHER LUNS ARE FOR THE FILES
C
C
C
        INCLUDE 'PLTWAV.COM'
        CALL TKCLER(1)
        PI=3.141592654
        CX1=CMPLX(1.,0.)
        CX2=CMPLX(2.,0.)
        CXJ=CMPLX(0.,1.)
        IRPT=0
        IZ=0
        ICOUNT=0
C
C  BEGIN TO INPUT DATA
C
C  IAUTO INDICATES RUNNING MODE
C
        WRITE(1,502)
        READ(2,7)IAUTO
 502    FORMAT(' HOW DO YOU WISH TO RUN?',//,
        1      ' 1 AUTOMATICALLY',/,
        2      ' 2 INTERACTIVELY',//,
        3      '$ TYPE 1 OR 2    ')
C
C IF AUTOMATIC JUMP TO 501--CALL READ(IZ)
C
        IF(IAUTO.EQ.1)GO TO 501
        CALL TKCLER(1)
C
C IDAT INDICATES DATA OUTPUT TYPE
C
        WRITE(1,2)
        READ(2,7)IDAT
 2      FORMAT(' WHAT TYPE OF DATA OUTPUT WOULD YOU LIKE?',//,
        1      '  1  NUMERICAL DATA FILES',/,
        2      '  2  PLOT FILES',/,
        3      '  3  BOTH',//,
        4      '$ TYPE 1,2, OR 3    ')
C
C ITYPE DESIGNATES STRUCTURE
C
        WRITE(1,1)
 1      FORMAT(/,' WHAT TYPE OF STRUCTURE DO YOU WANT TO ANALYZE?',//,
        2      '  1 SIMPLE PLATE',/,
        3      '  2 COMPOSITE WITH WELDED INTERFACE',/,
        4      '  3 COMPOSITE WITH SLIPPING INTERFACE',/,
        5      '  4 CONSTRAINED LAYER-WELDED INTERFACE',//,
        6      '$TYPE 1, 2, 3,OR 4    ')
        READ(2,7)ITYPE
 7      FORMAT(I1)
C
C ISERCH INDICATES SEARCH PARAMETERS
C
        WRITE(1,8)
 8      FORMAT(/,' WHAT TYPE OF SEARCH?',//,
        8      '  1 THROUGH EMISSION ANGLE',/,
        9      '  2 THROUGH FREQUENCY',//,
        7      '$TYPE 1 OR 2    ')
        READ(2,7)ISERCH
```

```
C
C  CALL FDAT IF A FREQUENCY SEARCH IS DESIRED
C
      IF(ISERCH.EQ.2)CALL FDAT(FMIN,FMAX,FINC,THETA)
C
C  CALL THDAT IF AN ANGLE SEARCH IS DESIRED
C
      IF(ISERCH.EQ.1)CALL THDAT(THMIN,THMAX,THINC,F)
C
C READ IN RO AND C
C
      WRITE(1,13)
 13   FORMAT('$FLUID DENSITY=',11X)
      READ(2,100)RO
 100  FORMAT(F10.0)
      WRITE(1,14)
      READ(2,100)C
 14   FORMAT('$FLUID SOUND SPEED=',7X)
C
C CALL READPL TO COLLECT PLATE DATA
C
      CALL READPL(HPLAT,ROPLAT,EPLAT,GPLAT)
C
C CALL READCO TO COLLECT COATING DATA
C
      IF(ITYPE.NE.1)CALL READCO(HCOAT,ROCOAT,ECOAT,GCOAT)
C
C CALL READCL TO COLLECT CONSTRAINING LAYER DATA
C
      IF(ITYPE.EQ.4)CALL READCL(HCONL,ROCONL,ECONL,GCONL)
C
C  CALL EDIT TO CHECK THE INPUT DATA
C
 500  CALL EDIT
C
C CALL READ IF AUTOMATICALLY RUNNING
C
 501  IF(IAUTO.EQ.1)CALL READ(IZ)
C
C COMPUTE THE NUMBER OF POINTS
C
 504  IF(ISERCH.EQ.1)NOPTS=(THMAX-THMIN)/THINC
      IF(ISERCH.EQ.2)NOPTS=(FMAX-FMIN)/FINC
C
C COMP COMPUTES PLATE PARAMETERS
C
      CALL COMP(KAPAPL,GP,DPLAT,VPLAT,GPLAT,EPLAT,HPLAT,CX1,CX2)
C
C CALL COMP TO COMPUTE COAT PARAMETERS
C
      IF(ITYPE.NE.1)CALL COMP(KAPACO,GC,DCOAT,VCOAT,GCOAT,
     1ECOAT,HCOAT,CX1,CX2)
C
C CALL COMP TOO COMPUTE CONS. LAYER PARAMETERS
C
      IF(ITYPE.EQ.4)CALL COMP(KAPACL,GL,DCONL,VCONL,GCONL,ECONL
     1,HCONL,CX1,CX2)
      IF(ITYPE.NE.1)BETA=HPLAT/HCOAT
C
C CHANGE ANGLES TO RADIANS
C
      THETA=THETA*0.0174532925
      THMIN=THMIN*0.0174532925
      THMAX=THMAX*0.0174532925
      THINC=THINC*0.0174532925
C
```

```
C INITIALIZE THE SEARCH
C
      IF(ISERCH.EQ.2)F=FMIN
      IF(ISERCH.EQ.1)THETA=THMIN
C
C  SET UP THE HEADER INFORMATION
C
      IF(IDAT.NE.1)CALL WAVPLT(THMIN,THMAX,THINC,FMIN,FMAX,FINC
     1,ISERCH,NOPTS)
C
C  OPEN THE DATA AND PLOT FILES
C
      CALL OPNFIL(GC,GP,GL)
C
C THIS LOOP DOES THE POINT CALCULATIONS
C
 50   DO 51 M=1,NOPTS
      KO=2.*PI*F/C
      K=KO*SIN(THETA)
      F2=(2.*PI*F)**2
C
C  COMPUTE THE ELASTIC RESPONSE FUNCTION
C
      IF(ITYPE.EQ.1)CALL OMEGA1(OMEGA,DPLAT,K,GP,HPLAT,ROPLAT
     1,F2,KO,RO)
      IF(ITYPE.EQ.2)CALL OMEGA2(OMEGA,F2,HPLAT,HCOAT,BETA
     1,ROPLAT,ROCOAT,GP,GC,K,KO,DPLAT,DCOAT,RO)
      IF(ITYPE.EQ.3)CALL OMEGA3(OMEGA,F2,HPLAT,HCOAT,ROPLAT
     1,ROCOAT,GP,GC,DPLAT,DCOAT,RO,K,KO)
      IF(ITYPE.EQ.4)CALL OMEGA4(OMEGA,F2,HPLAT,HCOAT,BETA,ROPLAT
     1,ROCOAT,GP,GC,K,KO,DPLAT,DCOAT,RO,HCONL,DCONL,ROCONL)
C
C COMPUTE REFLECTED AND RADIATED SOUND
C
      CXCOS=CMPLX(COS(THETA),0.)
      CXDUM=CX1/(CX1+CXJ*OMEGA*CXCOS)
      REF=CX1-CX2*CXDUM
      RAD=CXCOS*CXDUM
C
C  FILL AN ARRAY WITH THE INFORMATION
C
      CALL WAVDAT(THETA,F,OMEGA,REF,RAD,WAVDT)
C
C  WRITE THE INFORMATION INTO THE FILES
C
      CALL WRTFIL(ISERCH,WAVDT,M,IDAT)
C
C INCREMENT THE SEARCH PARAMETER
C
      IF(ISERCH.EQ.1)THETA=THETA+THINC
      IF(ISERCH.EQ.2)F=F+FINC
 51   CONTINUE
 52   DO 53 I=3,11
 53   CLOSE(UNIT=I)
C
C CHECK TO SEE IF ANOTHER SEARCH IS WANTED WITH A CHANGE IN PARAMETERS
C
      ICOUNT=ICOUNT+1
      IF(IAUTO.EQ.1)WRITE(1,300)ICOUNT
 300  FORMAT(' RUN NUMBER ',I2,' IS COMPLETED')
      IF(IAUTO.EQ.1)GO TO 301
      WRITE(1,55)
      WRITE(1,56)
      WRITE(1,57)
      READ(2,7)IRPT
      IF(IRPT.EQ.0)GO TO 58
```

```
C
C IF ANOTHER RUN. ANGLES ARE CHANGED BACK TO DEGREES
C
 301    THETA=THETA*57.29577951
        THMIN=THMIN*57.29577951
        THMAX=THMAX*57.29577951
        THINC=THINC*57.29577951
C
C GO BACK TO EDIT TO MAKE THE PARAMETER CHANGE
C
        IF(IAUTO.EQ.1)CALL READ(IZ)
        IF(IRPT.EQ.0)GO TO 58
        IF(IAUTO.EQ.1)GO TO 504
        GO TO 500
 55     FORMAT(//,' DO YOU WANT TO REPEAT THE SEARCH WITH')
 56     FORMAT('  A CHANGE IN VARIABLES?',//)
 57     FORMAT('$ TYPE 1 FOR YES, 0 FOR NO  ')
 58     WRITE(1,54)
 54     FORMAT(' **** PLTWAV IS NOW FINISHED ****')
        END
```

```
      SUBROUTINE TKCLER(LCO)
C
C THIS SUBROUTINE WILL CLEAR THE 4010 TERMINAL SCREEN.
C THIS SUBROUTINE IS ALSO MODIFIED TO CLEAR THE MINI-TEC
C TERMINAL SCREEN. (7 AUG 76)
C
C
C LCO IS THE LUN NUMBER ASSIGNED TO CO:
C
      BYTE BUFFO(2),MINI(2)
      INTEGER IPRM(6)

      DATA MESC/27/,MFF/12/
      DATA MINI/"34,"000/

C
C FIRST THE MINI-TEC
C
      CALL GETADR(IPRM,MINI)
      IPRM(2)=1
      CALL WTQIO("410,LCO,1,,,IPRM)
C
C NOW THE 4010
C
      BUFFO(1)=MESC
      BUFFO(2)=MFF

      CALL GETADR(IPRM,BUFFO(1))
      IPRM(2)=2

      CALL WTQIO("410,LCO,1,,,IPRM)

C
C NOW BEFORE RETURNING, DELAY ONE SECOND.
C
      CALL WAIT(1,2,M)
      RETURN
      END
```

```
      SUBROUTINE READ(IZ)
C
C THIS ROUTINE IS USED BY PLTWAV WHEN RUNNING IN THE AUTOMATIC MODE
C
C THE FILE 'PLTWAV.DAT' IS READ FOR DATA AND COMMANDS
C
C THE FILE 'NOTES.MDR' WILL GIVE ASSISTANCE IN WRITING THE DATA FILE
C
      INCLUDE 'PLTWAV.COM'
      IF(IZ.EQ.1)GO TO 100
      OPEN(UNIT=13,NAME='PLTWAV.DAT',TYPE='OLD')
      IZ=1
C
C SPECIFY DATA OUTPUT. STRUCTURE, AND SEARCH TYPE
C
      READ(13,104)IDAT
      READ(13,104)ITYPE
      READ(13,104)ISERCH
C
C SPECIFY SEARCH PARAMETERS
C
      IF(ISERCH.EQ.1)READ(13,106)THMIN
      IF(ISERCH.EQ.1)READ(13,106)THMAX
      IF(ISERCH.EQ.1)READ(13,106)THINC
      IF(ISERCH.EQ.1)READ(13,106)F
      IF(ISERCH.EQ.2)READ(13,106)FMIN
      IF(ISERCH.EQ.2)READ(13,106)FMAX
      IF(ISERCH.EQ.2)READ(13,106)FINC
      IF(ISERCH.EQ.2)READ(13,106)THETA
C
C SPECIFY FLUID PARAMETERS
C
      READ(13,106)RO
      READ(13,106)C
 103  FORMAT(2F10.0)
C
C SPECIFY PLATE PARAMETERS
C
      READ(13,106)HPLAT
      READ(13,106)ROPLAT
      READ(13,103)EPLAT
      READ(13,103)GPLAT
C
C SPECIFY COATING PARAMETERS
C
      IF(ITYPE.NE.1)READ(13,106)HCOAT
      IF(ITYPE.NE.1)READ(13,106)ROCOAT
      IF(ITYPE.NE.1)READ(13,103)ECOAT
      IF(ITYPE.NE.1)READ(13,103)GCOAT
C
C SPECIFY CONSTRAINING LAYER PARAMETERS
C
      IF(ITYPE.EQ.4)READ(13,106)HCONL
      IF(ITYPE.EQ.4)READ(13,106)ROCONL
      IF(ITYPE.EQ.4)READ(13,103)ECONL
      IF(ITYPE.EQ.4)READ(13,103)GCONL
      RETURN
C
C THIS SECTION ONLY AFTER FIRST RUN
C
C IF NO SECOND RUN (OR MORE RUNS AT ALL) SIMPLY HAVE A ZERO '0'
C  AS THE NEXT NUMBER IN 'PLTWAV.DAT'
C
 100  READ(13,104)IRPT
      IF(IRPT.EQ.0)GO TO 108
C
```

```
C ICHANG IS THE SAME HERE AS IN 'EDIT' WITH THE ADDITION OF IDAT,ITYPE
C  AND ISERCH AT THE END OF THE LIST
C
C EXIT THE ROUTINE WITH ICHANG=0
C
 107    READ(13,105)ICHANG
        IF(ICHANG.EQ.0)RETURN
 104    FORMAT(I1)
 105    FORMAT(I2)
        GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18
       1,19,20,21,22,23,24,25)ICHANG
 1      READ(13,106)THMIN
        GO TO 107
 106    FORMAT(F10.0)
 2      READ(13,106)THMAX
        GO TO 107
 3      READ(13,106)THINC
        GO TO 107
 4      READ(13,106)F
        GO TO 107
 5      READ(13,106)FMIN
        GO TO 107
 6      READ(13,106)FMAX
        GO TO 107
 7      READ(13,106)FINC
        GO TO 107
 8      READ(13,106)THETA
        GO TO 107
 9      READ(13,106)C
        GO TO 107
 10     READ(13,106)RO
        GO TO 107
 11     READ(13,106)HPLAT
        GO TO 107
 12     READ(13,106)ROPLAT
        GO TO 107
 13     READ(13,103)EPLAT
        GO TO 107
 14     READ(13,103)GPLAT
        GO TO 107
 15     READ(13,106)HCOAT
        GO TO 107
 16     READ(13,106)ROCOAT
        GO TO 107
 17     READ(13,103)ECOAT
        GO TO 107
 18     READ(13,103)GCOAT
        GO TO 107
 19     READ(13,106)HCONL
        GO TO 107
 20     READ(13,106)ROCONL
        GO TO 107
 21     READ(13,103)ECONL
        GO TO 107
 22     READ(13,103)GCONL
        GO TO 107
 23     READ(13,104)IDAT
        GO TO 107
 24     READ(13,104)ITYPE
        GO TO 107
 25     READ(13,104)ISERCH
        GO TO 107
 108    CLOSE(UNIT=13)
        RETURN
        END
```

```
      SUBROUTINE FDAT(FMIN,FMAX,FINC,THETA)
C
C
C THIS ROUTINE PROVIDES DIALOGUE FOR INPUTING FREQUENCY DATA
C    WHEN A FREQUENCY SEARCH IS SPECIFIED FROM PLTWAV
C
      CALL TKCLER(1)
      WRITE(1,1)
1     FORMAT(' SOME INFORMATION IS NEEDED.',//,
     1       ' THE PARAMETERS CAN BE INPUT USING ANY FORMAT.',/,
     2       ' THE COMPLEX PARAMETERS CAN BE SEPERATED INTO',/,
     3       ' REAL AND IMAGINARY PARTS BY A COMMA.',//,
     4       '$MINIMUM FREQUENCY=',7X)
      READ(2,10)FMIN
      WRITE(1,6)
      READ(2,10)FMAX
      WRITE(1,7)
      READ(1,10)FINC
      WRITE(1,8)
      READ(2,10)THETA
6     FORMAT('$MAXIMUM FREQUENCY=',7X)
7     FORMAT('$FREQUENCY INCREMENT=',5X)
8     FORMAT('$INCEDENCE ANGLE THETA=',3X)
10    FORMAT(F10.0)
      RETURN
      END
```

```
      SUBROUTINE THDAT(THMIN,THMAX,THINC,F)
C
C
C THIS ROUTINE PROVIDES DIALOGUE FOR INPUTING ANGLE DATA
C    WHEN A ANGLE SEARCH IS SPECIFIED FROM PLTWAV
C
      CALL TKCLER(1)
      WRITE(1,1)
 1    FORMAT(' SOME INFORMATION IS NEEDED.',//,
     1       ' THE PARAMETERS CAN BE INPUT USING ANY FORMAT.',/,
     2       ' THE COMPLEX PARAMETERS CAN BE SEPERATED INTO',/,
     3       ' REAL AND IMAGINARY PARTS BY A COMMA.',//,
     4       '$MINIMUM THETA=',11X)
      READ(2,10)THMIN
      WRITE(1,6)
      READ(2,10)THMAX
      WRITE(1,7)
      READ(1,10)THINC
      WRITE(1,8)
      READ(2,10)F
 6    FORMAT('$MAXIMUM THETA=',11X)
 7    FORMAT('$THETA INCREMENT=',9X)
 8    FORMAT('$FREQUENCY=',15X)
 10   FORMAT(F10.0)
      RETURN
      END
```

```
      SUBROUTINE READPL(HPLAT,ROPLAT,EPLAT,GPLAT)
      COMPLEX GPLAT,EPLAT
C
C
C  THIS ROUTINE TAKES INPUT DATA PERTAINING TO THE PLATE
C   WHEN CALLED BY PLTWAV
C
      WRITE(1,1)
      READ(2,10)HPLAT
      WRITE(1,2)
      READ(2,10)ROPLAT
      WRITE(1,4)
      READ(2,11)EPLAT
      WRITE(1,3)
      READ(2,11)GPLAT
 1    FORMAT('$THICKNESS OF PLATE=',6X)
 2    FORMAT('$DENSITY OF PLATE=',8X)
 3    FORMAT('$SHEAR MOD. OF PLATE=',5X)
 4    FORMAT('$YOUNGS MOD. OF PLATE=',4X)
 10   FORMAT(F10.0)
 11   FORMAT(2F10.0)
      RETURN
      END
```

```
      SUBROUTINE READCO(HCOAT,ROCOAT,ECOAT,GCOAT)
      COMPLEX ECOAT,GCOAT
C
C  THIS ROUTINE TAKES INPUT DATA PERTAINING TO THE COATING
C   WHEN CALLED BY PLTWAV
C
      WRITE(1,1)
      READ(2,10)HCOAT
      WRITE(1,2)
      READ(2,10)ROCOAT
      WRITE(1,3)
      READ(2,11)ECOAT
      WRITE(1,4)
      READ(2,11)GCOAT
1     FORMAT('$THICKNESS OF COATING=',4X)
2     FORMAT('$DENSITY OF COATING=',6X)
3     FORMAT('$YOUNGS MOD. OF COATING=',2X)
4     FORMAT('$SHEAR MOD. OF COATING=',3X)
10    FORMAT(F10.0)
11    FORMAT(2F10.0)
      RETURN
      END
```

```
      SUBROUTINE READCL(HCONL,ROCONL,ECONL,GCONL)
      COMPLEX GCONL,ECONL
C
C
C   THIS ROUTINE TAKES INPUT DATA PERTAINING TO THE CONSTRAINED
C       LAYER WHEN CALLED BY PLTWAV
C
      WRITE(1,1)
      READ(2,10)HCONL
      WRITE(1,2)
      READ(2,10)ROCONL
      WRITE(1,4)
      READ(2,11)ECONL
      WRITE(1,3)
      READ(2,11)GCONL
 1    FORMAT('$THICKNESS OF CONS. LAYER=',6X)
 2    FORMAT('$DENSITY OF CONS. LAYER=',8X)
 3    FORMAT('$SHEAR MOD. OF CONS. LAYER=',5X)
 4    FORMAT('$YOUNGS MOD. OF CONS. LAYER=',4X)
 10   FORMAT(F10.0)
 11   FORMAT(2F10.0)
      RETURN
      END
```

```
      SUBROUTINE EDIT
C
C THIS ROUTINE ALLOWS THE USER OF PLTWAV TO CHECK THE INPUT DATA
C  THROUGH INTERACTIVE DIALOGUE
C
C
      INCLUDE 'PLTWAV.COM'
C
 99   I=0
      CALL TKCLER(1)
      IF(ISERCH.EQ.2)GO TO 5
 1    WRITE(1.101)THMIN
      IF(I.EQ.1)READ(2.200)THMIN
      IF(I.EQ.1)GO TO 99
 2    WRITE(1.102)THMAX
      IF(I.EQ.1)READ(2,200)THMAX
      IF(I.EQ.1)GO TO 99
 3    WRITE(1.103)THINC
      IF(I.EQ.1)READ(2.200)THINC
      IF(I.EQ.1)GO TO 99
 4    WRITE(1.104)F
      IF(I.EQ.1)READ(2.200)F
      IF(I.EQ.1)GO TO 99
      GO TO 9
 5    WRITE(1.105)FMIN
      IF(I.EQ.1)READ(2.200)FMIN
      IF(I.EQ.1)GO TO 99
 6    WRITE(1.106)FMAX
      IF(I.EQ.1)READ(2.200)FMAX
      IF(I.EQ.1)GO TO 99
 7    WRITE(1.107)FINC
      IF(I.EQ.1)READ(2.200)FINC
      IF(I.EQ.1)GO TO 99
 8    WRITE(1.108)THETA
      IF(I.EQ.1)READ(2.200)THETA
      IF(I.EQ.1)GO TO 99
 9    WRITE(1.109)C
      IF(I.EQ.1)READ(2.200)C
      IF(I.EQ.1)GO TO 99
 10   WRITE(1.110)RO
      IF(I.EQ.1)READ(2.200)RO
      IF(I.EQ.1)GO TO 99
 11   WRITE(1.111)HPLAT
      IF(I.EQ.1)READ(2.200)HPLAT
      IF(I.EQ.1)GO TO 99
 12   WRITE(1.112)ROPLAT
      IF(I.EQ.1)READ(2.200)ROPLAT
      IF(I.EQ.1)GO TO 99
 13   WRITE(1.113)EPLAT
      IF(I.EQ.1)READ(2.201)EPLAT
      IF(I.EQ.1)GO TO 99
 14   WRITE(1.114)GPLAT
      IF(I.EQ.1)READ(2.201)GPLAT
      IF(I.EQ.1)GO TO 99
      IF(ITYPE.EQ.1)GO TO 26
 15   WRITE(1.115)HCOAT
      IF(I.EQ.1)READ(2.200)HCOAT
      IF(I.EQ.1)GO TO 99
 16   WRITE(1.116)ROCOAT
      IF(I.EQ.1)READ(2.200)ROCOAT
      IF(I.EQ.1)GO TO 99
 17   WRITE(1.117)ECOAT
      IF(I.EQ.1)READ(2.201)ECOAT
      IF(I.EQ.1)GO TO 99
 18   WRITE(1.118)GCOAT
      IF(I.EQ.1)READ(2.201)GCOAT
```

```
        IF(I.EQ.1)GO TO 99
        IF(ITYPE.NE.4)GO TO 26
19      WRITE(1.119)HCONL
        IF(I.EQ.1)READ(2.200)HCONL
        IF(I.EQ.1)GO TO 99
20      WRITE(1.120)ROCONL
        IF(I.EQ.1)READ(2.200)ROCONL
        IF(I.EQ.1)GO TO 99
21      WRITE(1.121)ECONL
        IF(I.EQ.1)READ(2.201)ECONL
        IF(I.EQ.1)GO TO 99
22      WRITE(1.122)GCONL
        IF(I.EQ.1)READ(2.201)GCONL
        IF(I.EQ.1)GO TO 99
26      WRITE(1.126)IDAT
        IF(I.EQ.1)READ(2.203)IDAT
        IF(I.EQ.1)GO TO 99
27      WRITE(1.127)ITYPE
        IF(I.EQ.1)READ(2.203)ITYPE
        IF(I.EQ.1)GO TO 99
28      WRITE(1.128)ISERCH
        IF(I.EQ.1)READ(2.203)ISERCH
        IF(I.EQ.1)GO TO 99
        I=1
        WRITE(1.23)
        WRITE(1.24)
        WRITE(1.25)
        READ(2.202)ICHANG
        IF(ICHANG.EQ.0)RETURN
        GO TO(1,2.3.4.5.6.7.8.9.10.11.12.13.14.15.16.17.18
       1.19.20.21.22.26.27.28)ICHANG
C
101     FORMAT('$ 1 THETA MIN=                ',F10.6,2X)
102     FORMAT('$ 2 THETA MAX=                ',F10.6,2X)
103     FORMAT('$ 3 THETA INCREMENT=          ',F10.6,2X)
104     FORMAT('$ 4 FREQUENCY=                 ',E12.6,2X)
105     FORMAT('$ 5 FREQ. MIN.=                ',E12.6,2X)
106     FORMAT('$ 6 FREQ. MAX.=                ',E12.6,2X)
107     FORMAT('$ 7 FREQ. INCREMENT=           ',E12.6,2X)
108     FORMAT('$ 8 THETA=                    ',F10.6,2X)
109     FORMAT('$ 9 FLUID SOUND SPEED=         ',E12.6,2X)
110     FORMAT('$ 10 FLUID DENSITY=            ',E12.6,2X)
111     FORMAT('$ 11 PLATE THICKNESS=         ',F10.6,2X)
112     FORMAT('$ 12 PLATE DENSITY=            ',E12.6,2X)
113     FORMAT('$ 13 YOUNGS MOD. OF PLATE=     ',2(E12.6,1X))
114     FORMAT('$ 14 SHEAR MOD. OF PLATE=      ',2(E12.6,1X))
115     FORMAT('$ 15 COAT THICKNESS=          ',F10.6,2X)
116     FORMAT('$ 16 COAT DENSITY=             ',E12.6,2X)
117     FORMAT('$ 17 YOUNGS MOD. OF COAT=      ',2(E12.6,1X))
118     FORMAT('$ 18 SHEAR MOD. OF COAT=       ',2(E12.6,1X))
119     FORMAT('$ 19 THICK. OF CONS. LAYER=',F10.6,2X)
120     FORMAT('$ 20 DENSITY OF CONS.LAYER = ',E12.6,2X)
121     FORMAT('$ 21 YOUNGS OF CONS. LAYER = ',2(E12.6,1X))
122     FORMAT('$ 22 SHEAR OF CONS. LAYER =  ',2(E12.6,1X))
126     FORMAT('$ 23  IDAT=                    ',I1)
127     FORMAT('$ 24  ITYPE=                   ',I1)
128     FORMAT('$ 25  ISERCH=                  ',I1)
23      FORMAT(//,' IF THESE ARE CORRECT TYPE 0')
24      FORMAT(' TO MAKE A CORRECTION, TYPE THE NUMBER')
25      FORMAT('  TO THE LEFT OF THE INCORRECT PARAMETER')
200     FORMAT(F10.0)
201     FORMAT(2F10.0)
202     FORMAT(I2)
203     FORMAT(I1)
        END
```

```
      SUBROUTINE COMP(KAPA,SG,D,V,G,E,H
     1,CX1,CX2)
C
      COMPLEX SG,D,E,G,V,CX1,CX2,KAPA
C
C
C
C THIS ROUTINE COMPUTES SOME PLATE PARAMETERS WHEN CALLED BY PLTWAV
C
      V=E/(CX2*G)-CX1
      KAPA=CMPLX(.87,0.)+CMPLX(1.12,0.)*V
      KAPA=KAPA/(CX1+V)
      SG=(KAPA**2)*G
      D=E*CMPLX(H**3,0.)
      D=D/(CMPLX(12.,0.)*(CX1-V**2))
      RETURN
      END
```

```
      SUBROUTINE WAVPLT(THMIN,THMAX,THINC,FMIN,FMAX,FINC,ISERCH,NOPTS)
C
C
      BYTE NAMDAT(11)
      DIMENSION IX(2),IY(2),IZ(2),IT(2)
      INTEGER BLOCK(8)
      EQUIVALENCE (THMI,IX(1)),(FMI,IY(1)),(THIN,IZ(1))
      EQUIVALENCE (FIN,IT(1))
C
C THIS CALLS HEADER FOR THE PLOT FILES USED BY PLTWAV
C
      THMA=THMAX*57.29577951
      THMI=THMIN*57.29577951
      FMI=FMIN
      FMA=FMAX
      THIN=THINC*57.29577951
      FIN=FINC
      IF(ISERCH.EQ.2)BLOCK(2)=NOPTS*2
      IF(ISERCH.EQ.1)BLOCK(2)=NOPTS*2
      IF(ISERCH.EQ.2)BLOCK(4)=IY(1)
      IF(ISERCH.EQ.2)BLOCK(5)=IY(2)
      IF(ISERCH.EQ.2)BLOCK(6)=IT(1)
      IF(ISERCH.EQ.2)BLOCK(7)=IT(2)
      IF(ISERCH.EQ.1)BLOCK(4)=IX(1)
      IF(ISERCH.EQ.1)BLOCK(5)=IX(2)
      IF(ISERCH.EQ.1)BLOCK(6)=IZ(1)
      IF(ISERCH.EQ.1)BLOCK(7)=IZ(2)
      BLOCK(1)=0
      BLOCK(3)=2
      BLOCK(8)=-1
      NAMDAT(1)='R'
      NAMDAT(2)='O'
      NAMDAT(3)='M'
      NAMDAT(4)='E'
      NAMDAT(5)='G'
      NAMDAT(6)='A'
      NAMDAT(7)='.'
      NAMDAT(8)='P'
      NAMDAT(9)='L'
      NAMDAT(10)='T'
      NAMDAT(11)=0
C
C FIRST PLOT FILE = ROMEGA.PLT
C
      CALL HEADER(NAMDAT,10,4,BLOCK)
C
C
      NAMDAT(1)='I'
C
C SECOND PLTO FILE = IOMEGA.PLT
C
      CALL HEADER(NAMDAT,10,5,BLOCK)
C
      NAMDAT(1)='M'
C
C THIRD PLOT FILE = MOMEGA.PLT
C
      CALL HEADER(NAMDAT,10,6,BLOCK)
C
      NAMDAT(1)='A'
C
C FOURTH PLOT FILE = AOMEGA.PLT
C
      CALL HEADER(NAMDAT,10,7,BLOCK)
C
      NAMDAT(1)='M'
```

```
      NAMDAT(2)='R'
      NAMDAT(3)='E'
      NAMDAT(4)='F'
      NAMDAT(5)='.'
      NAMDAT(6)='P'
      NAMDAT(7)='L'
      NAMDAT(8)='T'
      NAMDAT(9)=0
      NAMDAT(10)=0
C
C FIFTH PLOT FILE=MREF.PLT
C
      CALL HEADER(NAMDAT,10,8,BLOCK)
C
      NAMDAT(1)='A'
C
C SIXTH PLOT FILE = AREF.PLT
C
      CALL HEADER(NAMDAT,10,9,BLOCK)
C
      NAMDAT(1)='M'
      NAMDAT(2)='R'
      NAMDAT(3)='A'
      NAMDAT(4)='D'
C
C SEVENTH PLOT FILE = MRAD.PLT
C
      CALL HEADER(NAMDAT,10,10,BLOCK)
C
      NAMDAT(1)='A'
C
C EIGHTH PLOT FILE = ARAD.PLT
C
      CALL HEADER(NAMDAT,10,11,BLOCK)
C
      RETURN
      END
```

```
      SUBROUTINE HEADER(FILE,NCHAR,LUN,BLOCK)
C
C BLOCK CONSISTS OF 8 WORDS.
C
C       WHEN    BLOCK(1)=0       TWO WORD REAL.
C       WHEN    BLOCK(1)=1       ONE WORD INTEGER.
C       WHEN    BLOCK(1)=2       FOUR WORD COMPLEX. (NOT IMPLEMENTED AS YET.)
C       WHEN    BLOCK(1)=3       TWO WORD INTEGER. (NOT IMPLEMENTED AS YET.)
C
C       BLOCK(2) IS THE NUMBER OF DATA POINTS IN INTEGER FORM.
C
C       WHEN    BLOCK(3)=1       Y DATA ONLY IS PRESENT.
C       WHEN    BLOCK(3)=2       BOTH X & Y DATA ARE PRESENT.
C
C       BLOCK(4) = FIRST HALF OF THE INITIAL VALUE OF X.
C       BLOCK(5) = SECOND HALF OF THE INITIAL VALUE OF X.
C
C       BLOCK(6) = FIRST HALF OF THE VALUE OF THE X INCREMENT.
C       BLOCK(7) = SECOND HALF OF THE VALUE OF THE X INCREMENT.
C
C       WHEN    BLOCK(8) = -1 (NULL) THERE IS NO EXPANDED INFO FOLLOWING.
C
      DIMENSION IHEAD(3)
      BYTE FILE(32),CCHAR(2),NAME(32)
      INTEGER INAME(127),BLOCK(8),BLK(8)
      EQUIVALENCE (ITERM,CCHAR),(IHEAD,BLK)
      EQUIVALENCE (XINIT,BLK(4)),(XDELT,BLK(6))
C
      DO 100 M=1,8
100   BLK(M)=BLOCK(M)
      DO 200 I=1,NCHAR
200   NAME(I)=FILE(I)
      LN=LUN
      N1=NCHAR+1
      NAME(N1)=0
      OPEN (UNIT=LN,NAME=NAME,FORM='UNFORMATTED')
      ICOUNT=1
      ITERM=BLOCK(8)
      IF(ITERM.NE.-1) RETURN
      WRITE (LN)IHEAD,XINIT,XDELT,ITERM
      CLOSE (UNIT=LN)
      RETURN
C
      ENTRY HEADRX(INAME,NUM,ICHAR,L)
C
C INAME IS A DUMMY VARIABLE FOR THE ARRAY NAME.
C
C NUM IS THE NUMBER OF INTEGER WORDS IN THE ARRAY. RANGE 0-127
C
C ICHAR IS AN ASCII CONTROL CHARACTER.
C
C WHEN L=-1 CLOSE THE FILE AFTER THE CURRENT INFO.
C
      IF(NUM.LT.128) GO TO 10
      TYPE 120
120   FORMAT(' NUM TO BIG !')
      RETURN
10    CCHAR(1)=ICHAR
      CCHAR(2)=NUM
      IF(ICOUNT.NE.1) GO TO 20
      WRITE (LN)IHEAD,XINIT,XDELT,ITERM
      ICOUNT=0
      GO TO 30
20    WRITE (LN)ITERM
30    IF(NUM.LT.1) GO TO 40
      DO 300 M=1,NUM
```

```
300     WRITE (LN)INAME(M)
40      IF(L.NE.-1) RETURN
        ITERM=-1
        WRITE (LN)ITERM
        CLOSE (UNIT=LN)
        RETURN
        END
```

```
      SUBROUTINE OPNFIL(GC.GP.GL)
C
C
C THIS ROUTINE OPENS A DATA FILE AND 8 PLOT FILES FOR PLTWAV
C
C
      INCLUDE 'PLTWAV.COM'

      OPEN(UNIT=3.NAME='WAVDT.DAT')
      IF(IDAT.EQ.1)GO TO 22
      OPEN(UNIT=4.NAME='ROMEGA.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=5.NAME='IOMEGA.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=6.NAME='MOMEGA.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=7.NAME='AOMEGA.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=8.NAME='MREF.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=9.NAME='AREF.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=10.NAME='MRAD.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
      OPEN(UNIT=11.NAME='ARAD.PLT'.TYPE='OLD'.ACCESS='APPEND',
     1FORM='UNFORMATTED')
C
C WHAT FOLLOWS IS WRITTEN INTO WAVDT.DAT FOR REFRENCE AT LATER TIMES
C
 22   IF(ITYPE.EQ.1)WRITE(3.1)
      IF(ITYPE.EQ.2)WRITE(3.2)
      IF(ITYPE.EQ.3)WRITE(3.3)
      IF(ITYPE.EQ.4)WRITE(3.23)
      IF(ISERCH.EQ.1)WRITE(3.4)
      IF(ISERCH.EQ.2)WRITE(3.5)
      WRITE(3.6)
      WRITE(3.51)
      WRITE(3.7)ROPLAT.ROCOAT.ROCONL
      WRITE(3.8)HPLAT.HCOAT.HCONL
      WRITE(3.9)GPLAT.GCOAT.GCONL
      WRITE(3.10)EPLAT.ECOAT.ECONL
      WRITE(3.11)VPLAT.VCOAT.VCONL
      WRITE(3.12)
      WRITE(3.13)GP.GC.GL
      WRITE(3.14)DPLAT.DCOAT.DCONL
      WRITE(3.15)KAPAPL.KAPACO.KAPACL
      WRITE(3.16)
      WRITE(3.17)C
      WRITE(3.18)RO
 1    FORMAT(' SIMPLE PLATE'./)
 2    FORMAT(' COMPOSITE PLATE WITH WELDED INTERFACE'./)
 3    FORMAT(' COMPOSITE PLATE WITH SLIPPING INTERFACE'./)
 23   FORMAT(' COMPOSITE PLATE. WELDED INTERFACE. WITH
     1 CONSTRAINED LAYER')
 4    FORMAT(' SEARCH THROUGH EMISSION ANGLE'./)
 5    FORMAT(' SEARCH THROUGH FREQUENCY',/)
 6    FORMAT(' INPUT PARAMETERS:',10X.'PLATE'.24X.'COATING',
     122X.'CONSTRAINED LAYER'./)
 51   FORMAT(21X.'REAL',9X.'COMPLEX',9X.'REAL'.9X.'COMPLEX'
     1.9X.'REAL'.9X.'COMPLEX'./)
 7    FORMAT(' DENSITY            RO= '.E12.6.17X.E12.6.17X.E12.6
     1.12X.' KG/METER**3')
 8    FORMAT(' THICKNESS           H= '.E12.6.17X.E12.6.17X.E12.6.13X.
     1'METERS')
 9    FORMAT(' SHEAR MODULUS     G= '.2(E12.6.1X).3X.2(E12.6.1X),3X
     1.2(E12.6.1X).' NT/SQ METER')
```

```
10      FORMAT(' YOUNGS MOD.       E= ',2(E12.6.1X).3X.2(E12.6.1X).3X
        1.2(E12.6.1X).' NT/SQ METER')
11      FORMAT(' POISSONS RATIO    V= ',2(E12.6.1X).3X.2(E12.6.1X).3X
        1.2(E12.6.1X))
12      FORMAT(/.' COMPUTED PARAMETERS:',/)
13      FORMAT(' MODIFIED SHEAR    G= ',2(E12.6.1X).3X.2(E12.6.1X).3X
        1.2(E12.6.1X).' NT/SQ METER')
14      FORMAT(' FLEX. REGIDITY    D= ',2(E12.6.1X).3X.2(E12.6.1X).3X
        1.2(E12.6.1X).' NT METERS')
15      FORMAT(' TIMOSHENKOS    KAPA= ',2(E12.6.1X).3X.2(E12.6.1X).3X
        1.2(E12.6.1X))
16      FORMAT(/.' FLUID PARAMETERS:',/)
17      FORMAT(' FLUID SOUND SPEED = ',E12.6.' METERS/SEC')
18      FORMAT(' FLUID DENSITY      = ',E12.6.' KG/METER**3')
        WRITE(3.19)
        IF(IDAT.NE.2)WRITE(3,20)
19      FORMAT(/.' ROMEGA=>THE REAL PART OF OMEGA'./
        1.       ' IOMEGA=>THE IMAGINARY PART OF OMEGA'./
        2.       ' MOMEGA=>THE MAGNITUDE OF OMEGA'./
        3.       ' AOMEGA=>THE PHASE OF OMEGA'./
        4.       ' MREF=>THE MAGNITUDE OF REFLECTION'./
        5.       ' AREF=>THE PHASE OF THE REFLECTION'./
        6        ' MRAD=>THE MAGNITUDE OF RADIATION'./
        7        ' ARAD=>THE PHASE OF THE RADIATION'./)
20      FORMAT(/.' THETA'.8X.'FREQ'.9X.'ROMEGA'.7X.'IOMEGA'.7X.'MOMEGA'
        1.7X.'AOMEGA'.7X.'MREF'.9X.'AREF'.9X.'MRAD'.9X.'ARAD')
        RETURN
        END
```

```
      SUBROUTINE WAVDAT(THETA,F,OM,RE,RA,WAVDT)
C
C
C THIS ROUTINE FILLS THE ARRAY WAVDT(10)
C
      DIMENSION OM(2),RE(2),RA(2),WAVDT(10)
C
C
      WAVDT(1)=THETA*57.29577951
      WAVDT(2)=F
      WAVDT(3)=OM(1)
      WAVDT(4)=OM(2)
      WAVDT(5)=SQRT((OM(1)**2)+(OM(2)**2))
      WAVDT(6)=ATAN2(OM(2),OM(1))
      IF(WAVDT(6).LT.0)WAVDT(6)=WAVDT(6)+180.
      WAVDT(7)=SQRT((RE(1)**2)+(RE(2)**2))
      WAVDT(8)=ATAN2(RE(2),RE(1))
      IF(WAVDT(8).LT.0)WAVDT(8)=WAVDT(8)+180.
      WAVDT(9)=SQRT((RA(1)**2)+(RA(2)**2))
      WAVDT(10)=ATAN2(RA(2),RA(1))
      IF(WAVDT(10).LT.0)WAVDT(10)=WAVDT(10)+180.
      RETURN
      END
```

```
      SUBROUTINE WRTFIL(ISERCH,WAVDT,IPTS,IDAT)
C
C THIS ROUTINE WRITES INTO ALL THE FILES FOR PLTWAV
C
      DIMENSION WAVDT(10)
      IF((IPTS/10)*10-IPTS)15,21,15
21    IF(IDAT.NE.2)WRITE(3,14)
14    FORMAT(/,' THETA',8X,'FREQ',9X,'ROMEGA',7X,'IOMEGA',7X,
     1'MOMEGA',7X,'AOMEGA',7X,'MREF',9X,'AREF',9X,'MRAD',9X,'ARAD')
15    IF(IDAT.NE.2)WRITE(3,10)(WAVDT(L),L=1,10)
10    FORMAT(10(E12.5,1X))
      IF(IDAT.EQ.1)GO TO 22
      DO 20 ILUN=4,11
      WRITE(ILUN)WAVDT(ISERCH)
20    WRITE(ILUN)WAVDT(ILUN-1)
22    RETURN

      END
```

```
      SUBROUTINE OMEGAI(OMEGA,DPLAT,K,GP,HPLAT,ROPLAT,F2,KO,RO)
C
C COMPUTES ELASTIC RESPONSE FUNCTION FOR A SIMPLE PLATE
C  WHEN CALLED BY PLTWAV
C
      COMPLEX OMEGA,DPLAT,GP
      REAL K,KO
C
      OMEGA=DPLAT*CMPLX((K**2),0.)+GP*CMPLX(HPLAT,0.)
C
      OMEGA=OMEGA-CMPLX(F2*ROPLAT*(HPLAT**3),0.)/CMPLX(12.,0.)
C
      OMEGA=CMPLX(K**2,0.)*((GP*CMPLX(HPLAT,0.))**2)/OMEGA
C
      OMEGA=OMEGA-GP*CMPLX(HPLAT*(K**2),0.)
C
      OMEGA=OMEGA+CMPLX((HPLAT*ROPLAT*F2),0.)
C
      OMEGA=OMEGA*CMPLX(KO,0.)/CMPLX(F2*RO,0.)
C
      RETURN
      END
```

```
      SUBROUTINE OMEGAZ(OMEGA,F2,HPLAT,HCOAT,BETA,ROPLAT,ROCOAT
     1,GP,GC,K,KO,DPLAT,DCOAT,RO)
C
C COMPUTES ELASTIC RESPONSE FUNCTION FOR THE WELDED INTERFACE
C  WHEN CALLED BY PLTWAV
C
      COMPLEX OMEGA,GPLAT,GCOAT,GP,GC,DPLAT,DCOAT
      REAL K,KO
C
      OMEGA=CMPLX(-F2*(HPLAT**2)*HCOAT/12*(BETA*ROPLAT-ROCOAT),0.)
C
      OMEGA=OMEGA+CMPLX(HPLAT,0.)*(GP-CMPLX(BETA,0.)*GC)
C
      OMEGA=OMEGA+CMPLX(K**2,0.)*(DPLAT-CMPLX(BETA**2,0.)*DCOAT)
C
      OMEGA=(GP+GC)*(GP-GC)*CMPLX((K**2)*(HPLAT**2),0.)/OMEGA
C
      OMEGA=OMEGA-GP*CMPLX(((K**2)*HPLAT),0.)
C
      OMEGA=OMEGA-GC*CMPLX(((K**2)*HCOAT),0.)
C
      OMEGA=OMEGA+CMPLX(F2*HPLAT*ROPLAT+F2*HCOAT*ROCOAT,0.)
C
      OMEGA=OMEGA*CMPLX(KO/(F2*RO),0.)
C
      RETURN
      END
```

```
      SUBROUTINE OMEGA3(OMEGA,F2,HPLAT,HCOAT,ROPLAT,ROCOAT
     1,GP,GC,DPLAT,DCOAT,RO,K,KO)
C
C THIS COMPUTES THE ELASTIC RESPONSE FUNCTION FOR SLIPPING INTERFACE
C   WHEN CALLED BY PLTWAV
C
      COMPLEX OMEGA,GP,GC,DPLAT,DCOAT,ART,BART
      REAL K,KO
C
      ART=CMPLX(F2*ROCOAT*(HCOAT**3)/12.,0.)
C
      ART=GC*CMPLX(HCOAT,0.)+DCOAT*CMPLX(K**2,0.)-ART
C
      ART=CMPLX(K**2,0.)*((GC**2)*CMPLX(HCOAT**2,0.))/ART
C
      BART=CMPLX(F2*ROPLAT*(HPLAT**3)/12.,0.)
C
      BART=GP*CMPLX(HPLAT,0.)+DPLAT*CMPLX(K**2,0.)-BART
C
      BART=CMPLX(K**2,0.)*((GP**2)*CMPLX(HPLAT**2,0.))/BART
C
      OMEGA=ART+BART
C
      OMEGA=OMEGA-GP*CMPLX((K**2)*HPLAT,0.)
C
      OMEGA=OMEGA-GC*CMPLX((K**2)*HCOAT,0.)
C
      OMEGA=OMEGA+CMPLX(F2*(HPLAT*ROPLAT+HCOAT*ROCOAT),0.)
C
      OMEGA=OMEGA*CMPLX(KO/(F2*RO),0.)
C
      RETURN
      END
```

```
      SUBROUTINE OMEGA4(OMEGA,F2,HPLAT,HCOAT,BETA,ROPLAT,ROCOAT
     1,GP,GC,K,KO,DPLAT,DCOAT,RO,HCONL,DCONL,ROCONL)
C
C COMPUTES ELASTIC RESPONSE FUNCTION FOR THE WELDED INTERFACE
C  WHEN CALLED BY PLTWAV
C
      COMPLEX OMEGA,GPLAT,GCOAT,GP,GC,DPLAT,DCOAT,DCONL
      REAL K,KO
C
      OMEGA=CMPLX(-F2*(HPLAT**2)*HCOAT/12*(BETA*ROPLAT-ROCOAT),0.)
C
      OMEGA=OMEGA+CMPLX(HPLAT,0.)*(GP-CMPLX(BETA,0.)*GC)
C
      OMEGA=OMEGA+CMPLX(K**2,0.)*(DPLAT-CMPLX(BETA**2,0.)*DCOAT)
C
      OMEGA=OMEGA+DCONL*CMPLX(HPLAT/HCONL,0.)*(K**2)
C
      OMEGA=(GP+GC)*(GP-GC)*CMPLX((K**2)*(HPLAT**2),0.)/OMEGA
C
      OMEGA=OMEGA-GP*CMPLX(((K**2)*HPLAT),0.)
C
      OMEGA=OMEGA-GC*CMPLX(((K**2)*HCOAT),0.)
C
      OMEGA=OMEGA+CMPLX(F2*HPLAT*ROPLAT+F2*HCOAT*ROCOAT,0.)
C
      OMEGA=OMEGA+CMPLX(F2*HCONL*ROCONL,0.)
C
      OMEGA=OMEGA*CMPLX(KO/(F2*RO),0.)
C
      RETURN
      END
```

## B-1
## RUNNING TRACE

```
MCR>RUN TRACE )
A
  HOW MANY CURVES (1-5)?  5 )

 SPECIFY PLOT FILE: DK1:AMRAD.PLT;1 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;2 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;3 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;4 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;5 )

SPECIFY ABSOLUTE SCALE LIMITS
 XMIN= 0 )
 XMAX= 90 )
 YMIN= 0 )
 YMAX= 1 )

RIGHT OR LEFT LABEL OPTION?
 TYPE R,L,OR 0 FOR NONE   R )

THE PAPER ALLIGNMENT MUST BE CHECKED
ANY LETTER WILL EXIT THIS ROUTINE
AENTER AN ORDERED PAIR CHECKPOINT  90,0 )
A ENTER AN ORDERED PAIR CHECKPOINT  0,1 )
  ENTER AN ORDERED PAIR CHECKPOINT  G )
A
 AT 10 INCHES FULL SCALE THERE ARE
68.2 UNITS PER INCH.  HOW MANY UNITS BELOW USUAL
 DO YOU WISH THE LABEL TO BE?  0 )
AAAAAAAAAA
```

Note: The 'A's are printed as the plotter turns on and off.

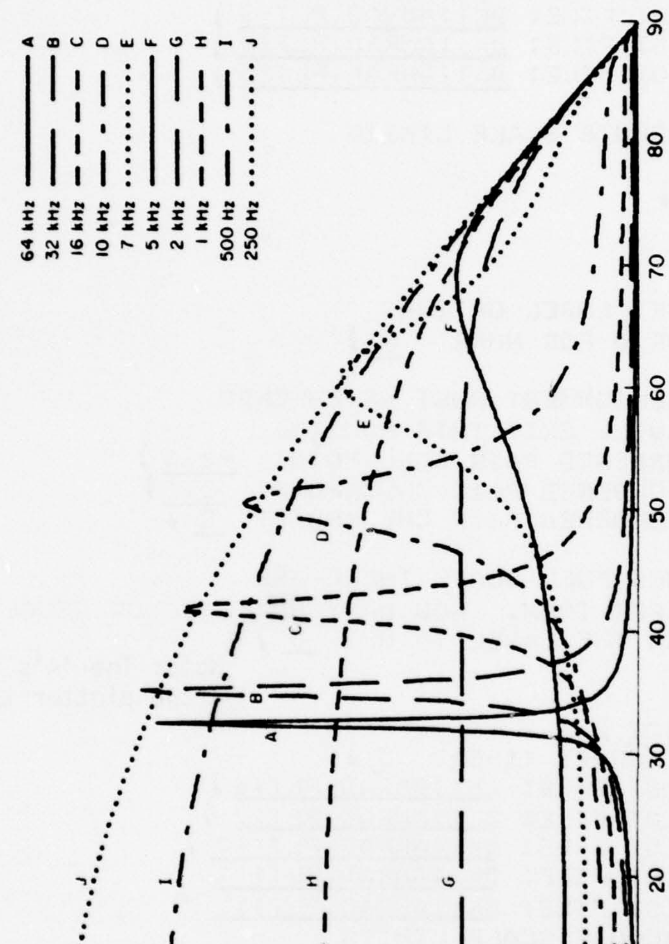
```
MCR>RUN TRACE )
  HOW MANY CURVES (1-5)?  5 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;6 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;7 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;10 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;11 )
 SPECIFY PLOT FILE: DK1:AMRAD.PLT;12 )
SPECIFY ABSOLUTE SCALE LIMITS
 XMIN= 0 )
 XMAX= 90 )
 YMIN= 0 )
 YMAX= 1 )
RIGHT OR LEFT LABEL OPTION?
 TYPE R,L,OR 0 FOR NONE   R )
THE PAPER ALLIGNMENT MUST BE CHECKED
ANY LETTER WILL EXIT THIS ROUTINE
AENTER AN ORDERED PAIR CHECKPOINT  G )
 AT 10 INCHES FULL SCALE THERE ARE
68.2 UNITS PER INCH.  HOW MANY UNITS BELOW USUAL
 DO YOU WISH THE LABEL TO BE?  136 )
```

Note: 1), All underlined portions are User supplied

2), ) means 'RETURN'

B-2

TRACE OUTPUT EXAMPLE



# B-3

# TRACE

## COMPILATION AND TASKBUILDING

THE PLOTTER PROGRAM 'TRACE' MUST ALSO BE COMPILED AND TASK BUILT. WHAT FOLLOWS ARE 1) THE 'F4P' COMMAND FILE CALLED 'TRACE.F4P', AND 2) THE COMMAND FILE FOR THE 'TKB' OPERATION, CALLED 'TRACE.TKB'. THE METHOD OF CALLING THESE COMMAND FILES IS THHE SAME AS FOR 'PLTWAV'.

```
TRACE.OBJ,TRACE.LST=TRACE.FTN/CK/TR/-SP/-RO
ARYFIL.OBJ,ARYFIL.LST=ARYFIL.FTN/CK/TR/-SP/-RO
RULE.OBJ,RULE.LST=RULE.FTN/CK/TR/-SP/-RO
ALLIGN.OBJ,ALLIGN.LST=ALLIGN.FTN/CK/TR/-SP/-RO
SETDSH.OBJ,SETDSH.LST=SETDSH.FTN/CK/TR/-SP/-RO
PON.OBJ,PON.LST=PON.FTN/CK/TR/-SP/-RO
TPLOT.OBJ,TPLOT.LST=TPLOT.FTN/CK/TR/-SP/-RO
TKDASH.OBJ,TKDASH.LST=TKDASH.FTN/CK/TR/-SP/-RO
TERM.OBJ,TERM.LST=TERM.FTN/CK/TR/-SP/-RO
QIOB.OBJ,QIOB.LST=QIOB.FTN/CK/TR/-SP/-RO
LABEL.OBJ,LABEL.LST=LABEL.FTN/CK/TR/-SP/-RO
```

```
TRACE,TRACE/SH/-SP=TRACE,ARYFIL,RULE,ALLIGN,SETDSH,TPLOT,TKDASH,
TERM,QIOB,PON,LABEL
/
LIBR=OTSCOR:RO
UNITS=6
ASG=TI:1:2:6
ASG=SY:3
/
```

# TRACE LISTING

```
C   TRACE.FTN
C
C        THIS PACKAGE OF ROUTINES CONSTITUTES A VERY SIMPLE PLOTTER.
C   AT THIS TIME THERE ARE NO PROVISIONS FOR DRAWING AXIS OR LABELING
C   ANYTHING.  HOWEVER, ABSOLUTE SCALING IS POSSIBLE, AND IF AXIS ARE
C   WANTED, A FILE WITH THE CORRECT COORDINATES CAN BE EASILY CONSTRUCTED
C
C
        BYTE NAME1(30),NAME2(30),NAME3(30),NAME4(30),NAME5(30),NAM(30)
        1,OPT(2)
C
        DIMENSION IARX(500),IARY(500),DASH(8)
C
C       INPUT THE NUMBER OF PLOTS, THEIR FILE SPECS, AND SCALE LIMITS
C
        L=1
        CALL POFF(6)
        WRITE(1,1)
        READ(2,2)NOCURV
 1      FORMAT('$ HOW MANY CURVES (1-5)?  ')
 2      FORMAT(I1)
C
C   GET THE FILE SPEC FOR CURVE 1
C
        WRITE(1,3)
 3      FORMAT('$ SPECIFY PLOT FILE: ')
        READ(2,4)NN,NAME1
 4      FORMAT(Q,30A1)
        NAME1(NN+1)=0
        IF(NOCURV.EQ.1)GO TO 20
C
C  GET THE FILE SPEC FOR CURVE 2
C
        WRITE(1,3)
        READ(2,4)NN,NAME2
        NAME2(NN+1)=0
        IF(NOCURV.EQ.2)GO TO 20
C
C  GET THE FILE SPEC FOR CURVE 3
C
        WRITE(1,3)
        READ(2,4)NN,NAME3
        NAME3(NN+1)=0
        IF(NOCURV.EQ.3)GO TO 20
C
C  GET THE FILE SPEC FOR CURVE 4
C
        WRITE(1,3)
        READ(2,4)NN,NAME4
        NAME4(NN+1)=0
        IF(NOCURV.EQ.4)GO TO 20
C
C  GET THE FILE SPEC FOR CURVE 5
C
        WRITE(1,3)
        READ(2,4)NN,NAME5
        NAME5(NN+1)=0
C
C  SET SCALE LIMITS
C
 20     WRITE(1,21)
 21     FORMAT(' SPECIFY ABSOLUTE SCALE LIMITS')
        WRITE(1,22)
        READ(2,25)XMIN
        WRITE(1,23)
        READ(2,26)XMAX
```

```
      WRITE(1,24)
      READ(2,26)YMIN
      WRITE(1,25)
      READ(2,26)YMAX
 22   FORMAT('$ XMIN= ')
 23   FORMAT('$ XMAX= ')
 24   FORMAT('$ YMIN= ')
 25   FORMAT('$ YMAX= ')
 26   FORMAT(F10.0)
C
C SPECIFY LABEL OPTION
C
      WRITE(1,27)
 27   FORMAT(' RIGHT OR LEFT LABEL OPTION?',/
     1,      '$ TYPE R.L.OR 0 FOR NONE    ')
      READ(2,28)NN,OPT
 28   FORMAT(Q,2A1)
      OPT(NN+1)=0
C
C COMPUTE SCALE
C
      X0=0.
      XEND=1023.
      Y0=0.
      YEND=682.
      DELTAX=XMIN-XMAX
      DELX=-1023/DELTAX
      CX=XMIN*1023/DELTAX
C
C  XVALUE=X*DELX+CX
C
      DELTAY=YMIN-YMAX
      DELY=-682/DELTAY
      CY=YMIN*682/DELTAY
C
C CHECK PAPER ALLIGNMENT
C
      CALL ALLIGN(DELX.X0.XEND.DELY.Y0.YEND.CX.CY)
C
C  DO THE PLOTTING
C
      DO 100 J=1.NOCURV
      CALL TERM(3.0)
      CALL POFF(6)
      DO 50 K=1.30
      IF(J.EQ.1)NAM(K)=NAME1(K)
      IF(J.EQ.2)NAM(K)=NAME2(K)
      IF(J.EQ.3)NAM(K)=NAME3(K)
      IF(J.EQ.4)NAM(K)=NAME4(K)
      IF(J.EQ.5)NAM(K)=NAME5(K)
 50   CONTINUE
      IF(NAM(1).EQ.'0')GO TO 100
      IF(OPT(1).NE.'0')CALL LABEL(J.OPT.L)
      L=L+1
C
C ARYFIL FILLS 2 ARRAYS WITH SCALED DATA FROM THE PLOT FILE
C
      CALL ARYFIL(IARX.IARY.NAM.DELX.DELY.X0.XEND.Y0.YEND.N.CX.CY
     1.XMIN.XMAX.YMIN.YMAX)
C
C SETDSH SETS UP THE PATTERN OF DASHES TO BE PLOTTED DEPENDING ON
C  THE NUMBER OF CURVES.
C
      CALL SETDSH(DASH.NDASH.J)
C
C PON TURNS ON THE PLOTTER
```

```
C
        CALL PON(6)
C
C PLOT THE POINTS INDIVIDUALLY
C
        DO 100 M=1,N
        CALL TKDASH(IARX(M),IARY(M),M,DASH,NDASH)
 100    CONTINUE
        CALL TERM(3.0)
        CALL POFF(6)
        END
```

```
      SUBROUTINE ARYFIL(IARX,IARY,NAM,DELX,DELY,X0,XEND,Y0
     1,YEND,N,CX,CY,XMIN,XMAX,YMIN,YMAX)
C
C THIS ROUTINE FILLS AN X ARRAY AND A Y ARRAY FOR TRACE.PAK
C
      BYTE NAM(30)
      DIMENSION IARX(500),IARY(500)
      OPEN(UNIT=3,ERR=13,NAME=NAM,TYPE='OLD',READONLY,FORM=
     1'UNFORMATTED')
      READ(3)IHEAD,XINIT,XDELT,ITERM
      DO 10 N=1,500
      READ(3,END=12)X
      READ(3,END=12)Y
      IF(X.GT.XMAX)X=XMAX
      IF(X.LT.XMIN)X=XMIN
      IF(Y.GT.YMAX)Y=YMAX
      IF(Y.LT.YMIN)Y=YMIN
      CALL RULE(X,Y,IX,IY,DELX,X0,XEND,DELY,Y0,YEND,CX,CY)
      IARX(N)=IX
      IARY(N)=IY
10    CONTINUE
12    CLOSE(UNIT=3)
      N=N-1
      RETURN
13    DO 20 N=1,20
      X=0
      Y=0
      CALL RULE(X,Y,IX,IY,DELX,X0,XEND,DELY,Y0,YEND)
      IARX(N)=IX
      IARY(N)=IY
20    CONTINUE
      CLOSE(UNIT=3)
      N=N-1
      RETURN
      END
      END
```

```
      SUBROUTINE RULE(X.Y.IX.IY.DELX.X0.XEND.DELY.Y0.YEND.CX.CY)
C
C THIS ROUTINE SCALES DATA FOR PLOT.PAK
C
      IX=X*DELX+CX
      IY=Y*DELY+CY
      IF(IX.GT.XEND)IX=XEND
      IF(IY.GT.YEND)IY=YEND
      IF(IX.LT.X0)IX=X0
      IF(IY.LT.Y0)IY=Y0
      RETURN
      END
```

```
      SUBROUTINE ALLIGN(DELX,X0,XEND,DELY,Y0,YEND,CX,CY)
C
C  THIS ROUTINE WILL AID IN CHECKING THE ALLIGNMENT OF THE PAPER ON
C  THE TEXTRONIX 4662 PLOTTER
C
      CALL ERRSET(64,.FALSE.,.FALSE.,)
C
      WRITE(1,1)
 1    FORMAT(' THE PAPER ALLIGNMENT MUST BE CHECKED')
      WRITE(1,3)
 2    WRITE(1,4)
 3    FORMAT(' ANY LETTER WILL EXIT THIS ROUTINE')
 4    FORMAT('$ ENTER AN ORDERED PAIR CHECKPOINT  ')
      READ(2,5,ERR=6)X,Y
 5    FORMAT(2F10.0)
      CALL RULE(X,Y,IX,IY,DELX,X0,XEND,DELY,Y0,YEND,CX,CY)
      CALL PON(6)
      CALL TPLOT(IX,IY,-1)
      CALL TERM(3,0)
      CALL POFF(6)
      GO TO 2
 6    RETURN
      END
```

```
      SUBROUTINE SETDSH(DASH,NDASH,J)
C
C  THIS ROUTINE SETS UP THE PATTERN OF BRIGHT AND DARK ARC SEGMENTS
C
      DIMENSION DASH(8)
      GO TO (10,20,30,40,50)J
C
C  SOLID LINE FOR CURVE #1
C
 10   NDASH=1
      DASH(1)=1005
      RETURN
C
C LONG DASH FOR CURVE #2
C
 20   NDASH=2
      DASH(1)=50
      DASH(2)=30
      RETURN
C
C SHORT DASH FOR CURVE #3
C
 30   NDASH=2
      DASH(1)=15
      DASH(2)=15
      RETURN
C
C LONG DASH-SHORT DASH FOR CURVE #4
C
 40   NDASH=4
      DASH(1)=30
      DASH(2)=20
      DASH(3)=5
      DASH(4)=20
      RETURN
C
C LONG-3 SHORT FOR CURVE #5
C
 50   NDASH=2
      DASH(1)=1
      DASH(2)=10
      RETURN
      END
```

```
      SUBROUTINE TPLOT (IX,IY,M)

C     SUBROUTINE TO PLOT ON THE TEKTRONIX 4010 AND 613 DISPLAY
C     TERMINALS (AS CHOSEN IN "TERM" SUBROUTINE).
C     FORTRAN-IV BUFFERED VERSION.

C     VALUES TO PLOT: IX,IY
C     MODES TO PLOT: M>0 (BRIGHT), M=0 (DARK), M<0 (POINT)
C     LUN 6: THIS SUBROUTINE USES QIOB.
C     REMEMBER TO PURGE THE BUFFER WHEN DONE (WITH TERM).

      BYTE IOUT(6)
      I=0
      IOUT(1)=000
      IF (M.GT.0) GOTO 11

C     INITIAL PLOT, DARK PLOT, POINT PLOT--
10    I=I+1
      IOUT(I)="35

C     ALL MODES--SEPARATE COORDINATES INTO HIGH- AND LOW-ORDER BYTES
11    I=I+1
      IOUT(I)=IY/32+32
      I=I+1
      IOUT(I)=96+IY-32*(IY/32)
      I=I+1
      IOUT(I)=IX/32+32
      I=I+1
      IOUT(I)=64+IX-32*(IX/32)

      IF (M.GE.0) GOTO 20
C     REINFORCE FOR POINT PLOT
12    I=I+1
      IOUT(I)=IOUT(I-1)

C     EXECUTE QIO AND RETURN
20    CALL QIOB ("610,6,24,0,IOUT,I,ISW)
      CALL WAITFR (24)

      RETURN
      END
```

```
C       TKDASH.FTN       J.D.GEORGE OCTOBER 1975
C
C THE PURPOSE OF SUBROUTINE TKDASH IS TO PLOT A CURVE AS A SERIES OF
C ALTERNATING BRITE AND DARK LINE SEGMENTS OF ARC LENGTHS SPECIFIED
C BY THE USER
C
C       SUBROUTINE TKDASH(IX,IY,N,DASH,NDASH)
C
C       IX,IY   ARE SCREEN OR PAPER COORDINATES
C
C       N       IS THE NUMBER OR INDEX OF THE POINT IX,IY
C               N=1, IS TREATED SEPERATELY, N.GE.I
C
C       DASH    IS AN ARRAY OF SCREEN COORDINATE ARC LENGTHS
C               FOR ALTERNATELY BRITE AND DARK LINE SEGMENTS
C               ODD INDICES ARE BRITE SEGMENTS
C               EVEN INDICES ARE DARK SEGMENTS
C               I.E.      I        1        2        3        4
C                      DASH(I)    10       10        2       10
C
C                                BRITE     DARK    BRITE     DARK
C
C       NDASH   IS THE LENGTH OF THE DASH ARRAY
C               4 SHOULD PROVIDE A WIDE RANGE OF SYMBOLS
C               TO FORCE ALTERNATE BRITE-DK LINE SEGMENTS
C               NDASH IS EVEN
C               FOR SOLID LINE USE NDASH = 1 & DASH(1)=LARGE*
C
C
C *****
C SUBROUTINES REQUIRED:TPLOT
C *****
C
C
C
C
        SUBROUTINE TKDASH(IX,IY,N,DASH,NDASH)
        DIMENSION DASH(NDASH)
        DATA ZERO/0.0/
        IF(N.GT.1)GOTO 100
C
C THE FIRST POINT INITIALIZES THINGS
C
        XLAST=IX
        YLAST=IY
        LASTDK=1
        IDASH=1
        OLDARC=ZERO
        CALL TPLOT(IX,IY,0)
        RETURN
C
C
C ENTRY FOR N.GT.1
C
100     CONTINUE
        X=IX
        Y=IY
C
C THE CODE BELOW IS REPEATED UNTIL HAVE PLOTTED SEGMENTS TO
C POINT IX,IY
C
200     CONTINUE
        DX=X-XLAST
        DY=Y-YLAST
        ARC=SQRT(DX*DX+DY*DY)
        IF(ARC.EQ.ZERO)GOTO 1000
```

```
C
C THE PATH DEPENDS ON WHETHER ARC EXTENDS BEYOND THE NEXT
C LINE SEGMENT SPECIFIED IN DASH(IDASH)
C
        IF((OLDARC+ARC).GE.(DASH(IDASH)))GOTO 300
C
C THE ARC TERMINATES WITHIN THE CURRENT LINE SEGMENT
C
        XINC=DX
        YINC=DY
        OLDARC=OLDARC+ARC
        GOTO 400
C
C
C THE ARC TERMINATES AT OR BEYOND THE CURRENT LINE SEGMENT
C
C
300     CONTINUE
        XINC=DX*(DASH(IDASH)-OLDARC)/ARC
        YINC=DY*(DASH(IDASH)-OLDARC)/ARC
        OLDARC=ZERO
C
400     CONTINUE
        X0=XLAST+XINC
        Y0=YLAST+YINC
C
C IF IDASH IS EVEN PLOT DARK VECTOR
C IF IDASH IS ODD PLOT BRITE VECTOR
C
C MODIFY TO NOTE THE TRANSITION FROM LITE TO DARK
C MOVE TO EDGE WITH DK VECTOR, THEN PUT DOWN DK VECTOR AT EDGE
C
C FOR DK VECTOR SKIP PLOTTING UNTIL SENSE LITE-TO-DK TRANSITION
C
        IDARK=MOD(IDASH,2)
        IX0=X0
        IY0=Y0
        IF(IDARK.EQ.0)GOTO 410
        IF(LASTDK.EQ.IDARK)GOTO 405
        IXLAST=XLAST
        IYLAST=YLAST
        CALL TPLOT(IXLAST,IYLAST,0)
        CALL TPLOT(IXLAST,IYLAST,1)
405     CONTINUE
        CALL TPLOT(IX0,IY0,IDARK)
410     LASTDK=IDARK
C
C SETUP FOR NEXT POINT
C
        XLAST=X0
        YLAST=Y0
C
C REPEAT PLOTTING UNTIL ARC TERMINATES WITHIN A
C SEGMENT OF DASH
C
C I.E. OLDARC.NE.ZERO
C
        IF(OLDARC.NE.ZERO)GOTO 1000
        IDASH=MOD(IDASH,NDASH)+1
        GOTO 200
C
C EXIT
C
1000    CONTINUE
        RETURN
        END
```

```
      SUBROUTINE PON (LUN)
C     SUBROUTINE TO TURN ON OR OFF THE TEKTRONIX 4662 PLOTTER.

      BYTE PLON(3),PLOFF(3)
      INTEGER IPRM(6)
      DATA PLON/27,65,69/PLOFF/27,65,70/


      CALL GETADR (IPRM,PLON)
      IPRM(2)=3
      CALL QIO ("410,LUN,24,,,IPRM,)
      CALL WAITFR (24)
      RETURN

      ENTRY POFF
      CALL GETADR (IPRM,PLOFF)
      IPRM(2)=3
      CALL QIO ("410,LUN,24,,,IPRM,)
      CALL WAITFR (24)
      RETURN

      END
```

```
      SUBROUTINE TERM(K,L)
C     THIS SUBROUTINE WILL MANIPULATE THE TERMINAL--
C     K=0, L=0  ERASE SCREEN
C     K=1, L=0  COPY SCREEN
C     K=2, L=0  RETURN TO ALPHA MODE
C     K=3, L=0  PURGE THE QIO BUFFER
C     K=B, L=C  IMPLEMENT MULTIPLEXER
C        WHERE B IS BOARD SELECT NUMBER 0-3
C        WHERE C IS CONTROL NUMBER TERMINAL(1), A(2), B(3), C(4)
C        (COMBINATIONS OF TERMINALS ARE ALLOWED)

C     THIS PARTICULAR VERSION IS FOR USE WITH BUFFERED
C     PLOTTING, AND EVERY CALL TO TERM WILL PURGE THE BUFFER.

      BYTE IOUT(3)

      I=2
      IOUT(1)="33      !ESCAPE

      IF (L.NE.0) GOTO 10
1     KX=K+1
      GOTO (2,3,5,40),KX
2     IOUT(2)="14                !CLEAR THE SCREEN
      GOTO 30
3     IOUT(2)="27                !COPY THE SCREEN
      GOTO 30
5     IOUT(1)="37                !RETURN TO ALPHA MODE
      I=1
      GOTO 30

C     PREPARE ASCII CHARACTERS FOR MUX BOARD AND CONTROL NUMBERS
10    IOUT(2)=K+"60
      IOUT(3)=2**(L-1)+"60
      I=3

C     OUTPUT THE CONTROL SEQUENCE
30    CALL QIOB ("610,5,24,0,IOUT,I,ISW)
C     AND PURGE THE BUFFER
40    CALL QIOP ("610,6,24,0,IDAT,0,ISW)

C     PAUSE A MOMENT IF SCREEN IS BEING CLEARED
      IF ((K+L).NE.0) RETURN
      CALL WAIT (1,2,M)
      RETURN

      END
```

```
      SUBROUTINE LABEL(J,OPT,L)
C
C THIS ROUTINE WILL DRAW A LINE SEGMENT IN THE RIGHT OR LEFT
C  CORNER OF THE GRAPH FOR TRACE.FTN   THE LINE TYPE WILL BE THE
C  SAME AS THE CURVE BEING DRAWN
C
      BYTE OPT(2)
      DIMENSION IARX(120),IARY(120),DASH(8)
      IF(OPT(1).EQ.'L')IARX(1)=30
      IF(OPT(1).EQ.'R')IARX(1)=873
      IF(L.EQ.1)WRITE(1,6)
 6    FORMAT(' AT 10 INCHES FULL SCALE THERE ARE',/
     1.' 68.2 UNITS PER INCH.  HOW MANY UNITS BELOW USUAL',/
     2.'$ DO YOU WISH THE LABEL TO BE?  ')
      IF(L.EQ.1)READ(2,7)K
 7    FORMAT(I3)
      DO 5 N=2,120
 5    IARX(N)=IARX(N-1)+1
      GO TO (10,20,30,40,50)L
 10   DO 11 N=1,120
 11   IARY(N)=668-K
      GO TO 60
 20   DO 21 N=1,120
 21   IARY(N)=641-K
      GO TO 60
 30   DO 31 N=1,120
 31   IARY(N)=614-K
      GO TO 60
 40   DO 41 N=1,120
 41   IARY(N)=586-K
      GO TO 60
 50   DO 51 N=1,120
 51   IARY(N)=559-K
 60   CALL SETDSH(DASH,NDASH,J)
      CALL PON(6)
      DO 61 N=1,120
      CALL TKDASH(IARX(N),IARY(N),N,DASH,NDASH)
 61   CONTINUE
      CALL TERM(3,0)
      CALL POFF(6)
      RETURN
      END
```